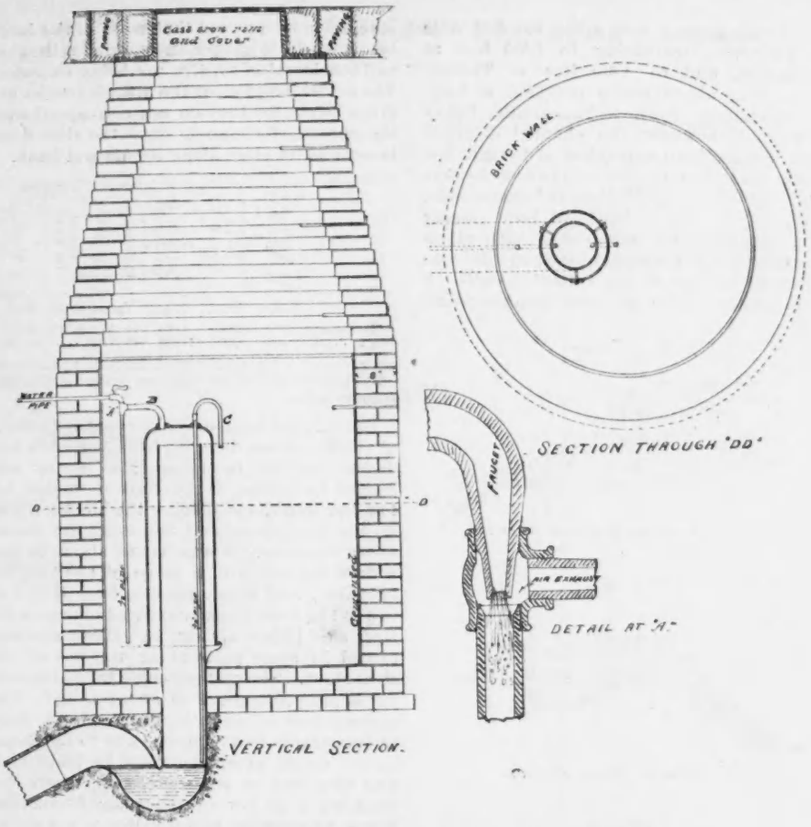


THE ROSEWATER AUTOMATIC FLUSH TANK.

(*Patented June 15, 1885.*)

THE syphon tank herein illustrated is the result of a series of experiments conducted by Andrew Rosewater, Mem. Am. Soc. Civil Engineers, during the past three years in the sewerage system of the city of Omaha. About fifty of these syphons with a diameter of 6 inches and of variable form have now been successfully in use for from six to eighteen months. The contracts for 1886 have called into requisition still larger syphons. The first two of 8-inch diameter were set and tested some time ago. They are of the pattern herein shown. They worked without any trouble discharging at the rate of 10½ gallons per second. The operation scarcely needs explanation. The passage of water into the tank through a faucet set into a T junction *A* as shown separately in detail operates as in a "mud pump" or "steam injector" to create a suction from the pipe *B* which connects with the top of the syphon, and owing to the seal in the trap below would exhaust the air from the syphon but for the air supply through the pipe *C*. However, as soon as the water in the tank reaches the lower end of the air supply pipe *C* it cuts off the ingress of air and as a result the air is soon exhausted from the syphon and complete syphonage takes place. The simplicity of this syphon commends it to every engineer at a glance. There being nothing to move or clog up in any manner, its operation is almost sure of remaining continuous year in and year out. For the same diameter of syphon owing to the absence of any lip its rate of discharge is claimed to be more than double that of the Roger Field's tank, and Mr. Rosewater further claims that unlike any other it needs no expert to set it up or adjust it.

Several engineers who have personally examined and seen its operation have concluded to apply it to works in their charge, and thirty of the larger sizes have been contracted for use in the Omaha storm sewer now under contract.

Eastern and Western Air Line Railway.

SUBSCRIPTIONS are invited for $5,000,000 First Mortgage Six per Cent. Bonds, being part of an authorized issue of $36,512,000 of first mortgage bonds required for the building of a direct main line of railway, commencing in Pennsylvania, and running to Council Bluffs, on the Missouri. When completed, the road will be 1,141 miles in length, and will effect a saving in distance—between 200 towns, which it will connect—of about 106 miles. The line will traverse 58 counties, all well settled and cultivated, having a population of two and a half millions, and exclusive of the share of trade with Chicago, having an aggregate business of 42 millions sterling. The proposed road will have more favorable gradients than any other trunk line in the United States, and its low debt will not exceed $32,000 per mile, as compared with an average of $93,875 on other lines of a similar national character. Sir Charles Bright, the engineer, estimates the net revenue of the line will be sufficient after the first year to pay more than double the interest at 6 per cent. on the whole amount of bonds to be issued. Of the total mileage of the road 146 consists of a road already constructed, and which is to form part of the system. The price at which the bonds are offered for subscription is £95 per £100 bond. The Farmers' Loan, and Trust Company are trustees of the mortgages in New York.

Trustees in England are Sir Francis Wyatt Truscott, Knt., Alderman of the city of London; Sir John Robert Heron-Maxwell, Bart., Trustee of the Manitoba and North-Western Railway Company of Canada; W. Leatham Bright, Esq., M. P. (Messrs. Tylor and Bright); Arthur Sperling, Esq., D. L., J. P., Chairman of Hand-in Hand Fire and Life Insurance Society.

The American Board of Directors, are Hon. Thomas W. Osborn, late United States Senator, *President*; Hon. James G. Day, late Chief Justice of Supreme Court of Iowa; Hon. James Conkling, Springfield, Illinois; George L. Artz, Esq., Columbus, O.; W. C. Mobley, Esq., Pittsburg Pennsylvania; Samuel Merrill, Esq., of New York; David Phillips, Esq., of New York; George Hubbard, Esq., of New York.

Engineer-in-Chief—Henry A. Schwanecke, C. E., of Pittsburg, U. S. A.

Consulting Engineer—Sir Charles Bright, Esq., M. Inst. C. E.

Secretary—James Hastings, Esq.

London Offices—80, Lombard Street, EC. —*Railway News.*

Cholera and Water Supply.

In a recent letter to *Nature*, Mr. George Higgin says that the epidemic of Asiatic cholera, which has been raging in Spain during the last two years, has furnished not a few interesting data as regards its connection with water supply. Mr. Higgin claims that cholera never became truly epdemic in any Spanish city in which there was a pure and good supply of water and proper means were used to guard the sources from pollution. In support of this idea he calls attention to the cities of Toledo, Seville, Malaga and Madrid, in contradistinction to such places Aranjuez, Saragossa, Granada and Valencia. Mr. Higgin shows very clearly that the fine condition and careful protection of the water supply of the cities first named was the main cause of the comparatively slight ravages of the disease within their limits. It seems, for example, that the ancient city of Toledo, into which the cholera entered in the summer of 1884, and did not leave until the autumn of 1885, furnished an official return of 200 cases of cholera, only one-half of which were fatal. As Toledo has a population of over 20,000 the percentage of choleric disease was about 1 per cent. of the population for the two seasons referred to. On the other hand, continues Mr. Higgin, the city of Granada, with a population of nearly 80,000 souls, is supplied with water by canals which are uncovered and exposed to all kinds of contamination. Through the streets the water is conducted in earthenware pipes, many of which are the original ones put down by the Moors before the conquest of the city by Ferdinand and Isabella. The cholera raged here with frightful results, says Mr. Higgin, the official number of cases reported being over 450 per day. No attempt was made, as was done at Toledo with such excellent results, to suppress the old water supply, and the epidemic took on alarming proportions in a very short time.

BESSEMER WORKS.—Messrs. Gordon, Strobel & Laureau, of Philadelphia, have closed a contract with the Belleville, (Ill.) Nail Company, for a complete Bessemer steel plant to consist of two 3-ton converters, with all engines, cranes, pumps, buildings, etc. It will have a capacity of 200 tons per day, and work on it will be commenced at once. They have also contracted with the Jefferson Iron Works, of Steubenville, Ohio, for a complete Bessemer plant, which will be identical with the Belleville plant.

SOUTH AMERICAN EXPOSITION.—The Peruvian Government will open a mining exposition at Lima, June 1, 1887.

The River Seine.*

BY LEVESON FRANCIS VERNON-HARCOURT, M. A., M. INST. C. E.

(*Continued from Page 4.*)

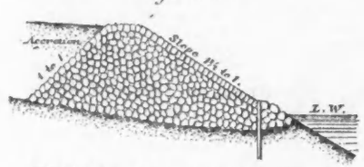
III. ESTUARY-WORKS.

The improvement-works carried out on the tidal Seine are much simpler in character than the inland works previously described, for they consist merely of mounds of rubble chalk forming longitudinal training-walls on each side of the channel; but they have produced most important changes in the navigable channel, and in the estuary beyond (Plate 4, Figs. 1 to 7, and Plate 5, Figs. 1 to 4).

The position of Rouen naturally marked it out for an inland port, for whilst situated near the head of the tidal Seine, it possesses water-communication with Paris. Whereas, however, the river has a stable bed in rock, clay and gravel, with a good natural depth for thirty-nine miles down to La Mailleraye, about half way between Rouen and the sea; below this point it flowed in a shallow, winding, changing channel through shifting sand-banks to the sea (Plate 5, Fig. 1). The shoals rose so high at Azier and Villequier that the depth of water over them at high-water spring-tides was about 10 feet, so that only vessels of from 100 to 200 tons could go up the river, and they frequently had to wait for a high enough tide. Four days at least were occupied in the voyage between the sea and Rouen; and the perils of navigation were aggravated by the bore, caused by the impediments offered by the shoals to the flood-tide in its passage up the estuary, and consequently wrecks frequently occurred. The charge for freight was 8s. per ton, and the rate of insurance was ½ per cent.

From the time of Louis XV. great anxiety was manifested for remedying the perils of the estuary, and numerous schemes were put forward by various engineers for the improvement of the river. Mr. Cachin, engineer of the Cherbourg breakwater, about the year 1770, proposed to avoid the estuary altogether by constructing a ship-canal along the left bank from near Villequier down to Honfleur. Others suggested the improvement of the river by groynes or by weirs; whilst Mr. Frimot proposed to narrow and train the river by two rows of caissons, along each side, filled with stones; and Mr. Bleschamps conceived the idea of substituting simple rubble longitudinal training-walls. Nothing, however, was accomplished till, in 1845, Mr. Bouniceau designed a plan for the improvement of the estuary by rubble training-walls from La Mailleraye to Havre, backed up by forcible arguments for its adoption (Plate 4, Figs. 1 and 9). In the following year, 1846, the improvement of the navigation between Villequier and Quillebeuf, by this method, was authorized; the left bank was commenced at Belcinac Island, opposite Villequier, in 1848, and the training-works reached Quillebeuf in 1851. These works immediately increased the depth at the shoals from 10½ to 21½ feet at spring-tides. Accordingly the extension of the training-walls was decreed, in 1852, from Villequier up to La Mailleraye, and from Quillebeuf down to Tancarville and La Roque (Plate 4, Fig. 1). The dredging also of the Meules bank, a little below La Mailleraye, was undertaken at the same time. The upper works were completed in 1856, the extension to Tancarville on the right bank having been finished in 1855; but the extension on the left bank to La Roque, with a cross bank from the point to its extremity in order to protect it, was not terminated till 1859. The channel between the embankments was made 980 feet wide at Villequier, increasing to 1,310 feet at Quillebeuf, and to 1,640 feet at Tancarville. The above works provided a deep, stable channel down to Tancarville. Below this point, however, the channel diverged from the southern embankment towards the north, and then turned southwards to Berville, and it was also shallow and changeable. Moreover the bore, which had been greatly reduced since 1854, reappeared with all its former power at the close of 1858, and did considerable damage to the retaining-walls. A prolongation of the northern retaining-wall was accordingly authorized in 1861 from Tancarville to La Roque, and the repair of the banks was commenced. The northern training-wall was completed to La Roque in 1863; and a further extension of the walls to Berville was decreed, which was completed in 1869 (Plate 5, Fig. 2). A prolongation of the southern bank for 1,300 yards below the mouth of the Rille was carried out in 1869-70; but a proposed prolongation of the northern bank in 1871, for a distance of 1¼ mile, was refused on behalf of Havre. The embankments, therefore, remain now at the points they had reached in 1870, except that most of the bank below the Rille has become covered with sand, and considerable repairs are being executed. The actual lengths of the training-walls are given below, for they do not correspond with the embanked channel, since the river flows in some parts close along its natural bank.

Fig: 3.

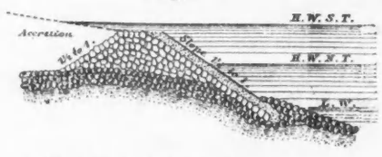


ORIGINAL TYPE OF TRAINING WALL.

Fig: 4.

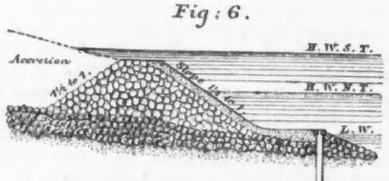
OLD TRAINING WALL RAISED.

Fig: 5.



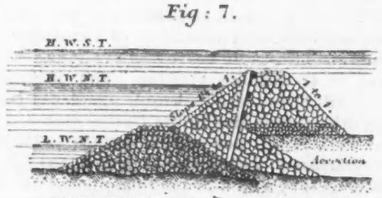
TRAINING WALL AS RE-CONSTRUCTED.

Fig: 6.



TRAINING WALL AS RE-CONSTRUCTED.

Fig: 7.



SOUTH TRAINING WALL BELOW LA ROQUE.
Showing Method of Raising.

Plate 4.

	La Mailleraye to Caudebec.	Caudebec to La Vaquerie.	La Vaquerie to Quillebeuf.	Quillebeuf to La Rille.	Below La Rille.	Total.
	Yrds.	Yrds.	Yrds.	Yrds.	Yrds.	Yrds.
Left Bank..	6,671	10,390	1,066	15,311	1,312	23,690
Rig't Bank.	6,835	9,077	13,670	15,311	....	44,893

The total length of the training walls is therefore about 45 miles.

The original training-walls consisted simply of rubble chalk quarried from the cliffs bordering the river in places. The mound was formed by tipping in the chalk at random below low-water, and placing the blocks, filling up the interstices, and trimming the slopes above low-water; it was made about 6½ feet wide at the top, with a slope of 1 to 1 on the land side, and slopes varying from 1½ to 1 up to 8 to 1 in exceptionally exposed places on the river side (Plate 4, Fig. 3). Piling also was placed in some parts along the toe of the river slope. The cost per cubic yard of mound put in place amounted to about 1*s.* 0½*d.* The mounds were raised to high-water level down to Tancarville on the north, and to La Roque on the south, except between La Mailleraye and Caudebec on the south side, where the bank was kept low for the sake of economy. Below Tancarville and La Roque low banks were adopted by Mr. Emmery, raised only 3½ feet and 1⅔ foot respectively above low-water of spring-tides, so that they might have less influence in promoting the accumulation of of deposits, which had already become a serious consideration.

The bore, which at some points causes a rapid rise in the river of about 10 feet, and appears in places as a breaking wave, together with the deepening of the river-bed by the training works, disturbed and undermined the training-walls, so that they required raising (Plate 4 Fig. 4). The simple addition of rubble chalk on the top of the old mounds was pursued for several years; but these banks could not sufficiently resist the action of the bore. Accordingly, in 1878, a new type of mound was adopted, the river slope being protected by a facing of concrete from 8 to 12 inches thick, and secured where necessary from undermining by a concrete apron, 15 inches thick and 10 feet wide, with piling and planking at its outer edge (Plate 4, Figs. 5 and 6). The training walls are being gradually reconstructed in this manner, which secures them against the bore. The low south training-wall below La Roque experienced such injuries from the rush of the tide over it at certain periods, that it has been raised to mean high water level, as shown in Plate 4, Fig. 7; and the north wall below Tancarville must be similarly dealt with.

The total cost of the works up to 1876 amounted to £678,060; in 1878 a sum of £144,000 was allotted for the reconstruction of the banks; and it was proposed in 1883 to expend a further sum of £376,000 in completing these repairs.

The training-works have effected a very remarkable increase in the depth between La Mailleraye and Berville, as indicated by comparing the longitudinal sections of the channel in 1824 and 1875 (Plate 4, Fig. 2). The minimum navigation depth between Havre and Rouen, at high-water neap-tides, has been increased from 10 feet to 18 feet. Vessels of

*Read before the Institution of Civil Engineers, February 16, 1886.

Fig: 1.

PLAN OF ESTUARY.

1880.

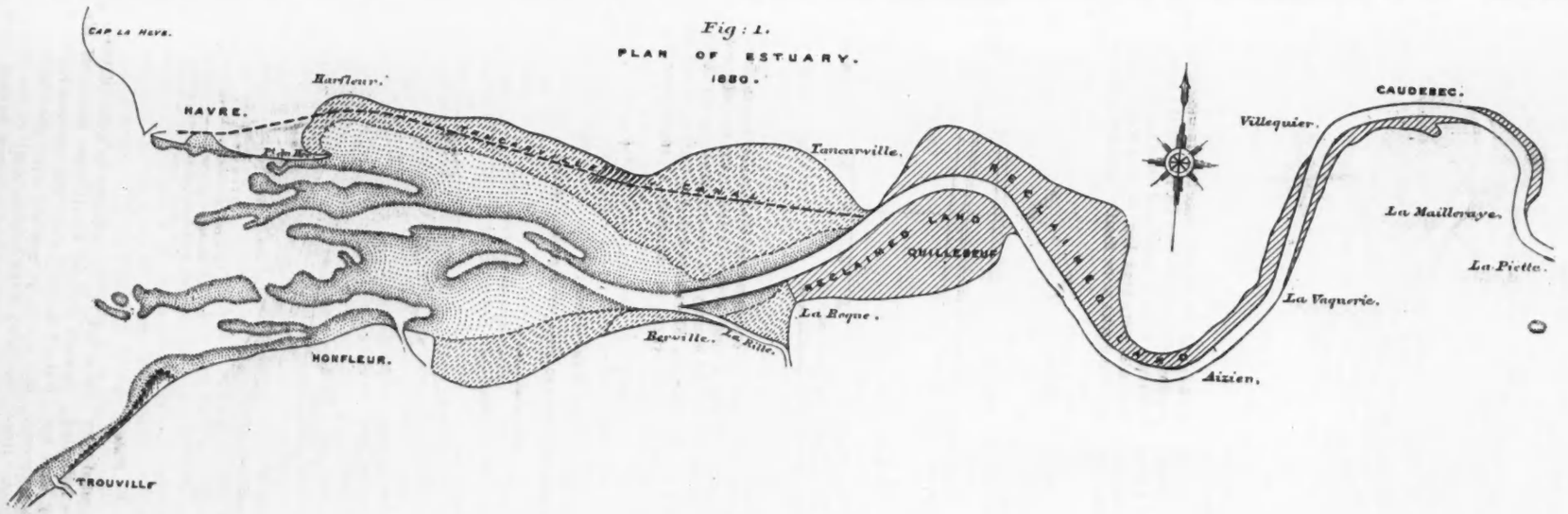


Fig: 2.

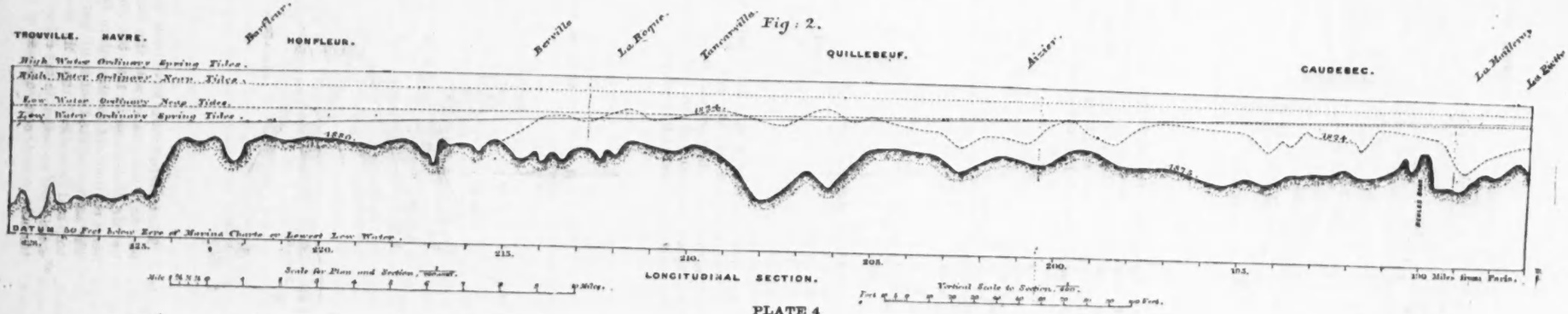


PLATE 4.

Fig: 13.

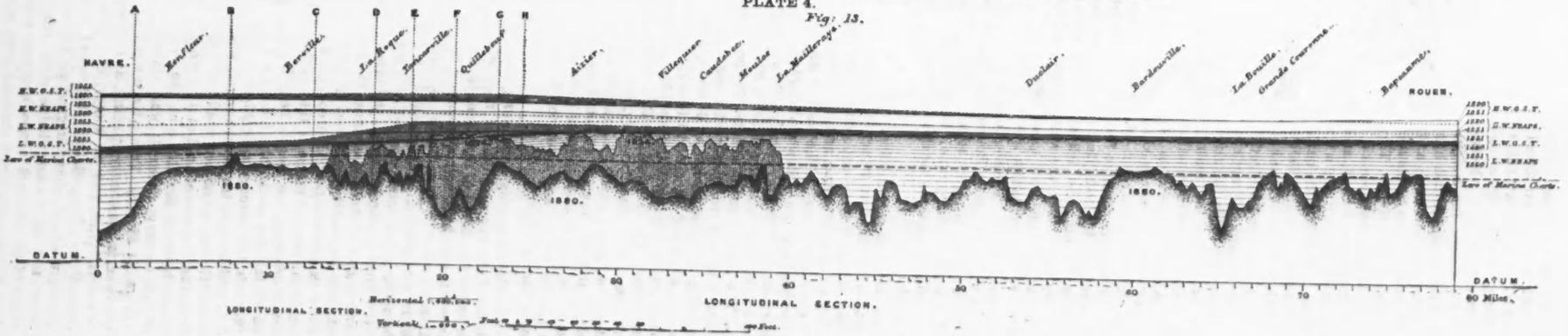


PLATE 5.

2,000 tons can navigate the river; and it has been found possible, under favorable conditions, to bring up a vessel drawing 21 feet. Moreover, the charge for freight between Havre and Rouen has been reduced to one half; and the rate of insurance for Rouen is the same as for Havre. The trade of Rouen has consequently greatly increased, and it has become the fifth port of France. The Meules bank is the shallowest point below La Mailleraye, but it could be still further lowered by dredging. Considerable alterations have been effected in the river channel at Rouen, but mainly with the object of increasing the quay accommodation of the port. These works consist in regulating the river where it is intersected by islands, so as to form one enlarged main channel, by modifying the lines of the banks, and joining the islands to the mainland. By this means, the wasted area of the islands is available for quay space; and the regulated banks are lined with quay walls. The shallow parts of the river between Rouen and St. Aubin are to be dredged, so as to provide a minimum depth of 13½ feet at high-water neap-tides for the up-river navigation.

Fig: 8.

PLAN OF ESTUARY.

SHOWING SCHEME FOR PROLONGATION OF TRAINING WALLS,

Suggested by L. P. Vernon-Harcourt.

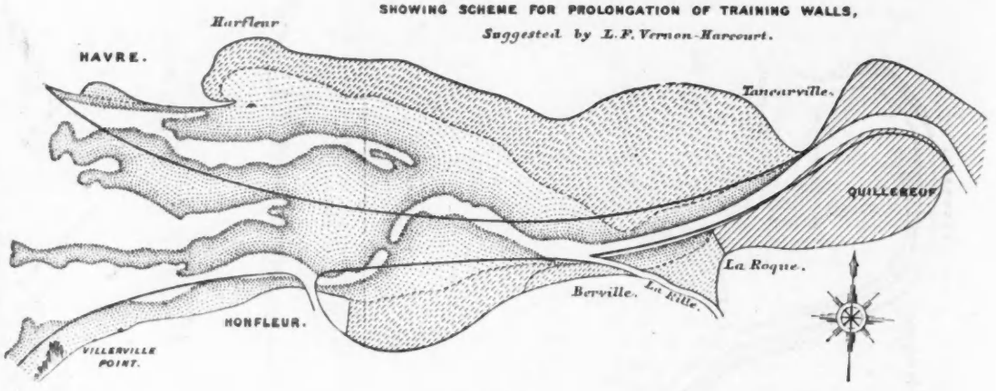


Plate 4.

The range of spring-tides, which amounts to 23 feet 7 inches at the mouth of the Seine, is reduced to about 10 feet at La Mailleraye, and to 6 feet 7 inches at Rouen. The variations in the tidal rise and flow at different places on the river are clearly indicated by the tidal diagram (Plate 4, Fig. 12). The improvement effected in the channel by the training-works has caused a lowering of the lowwater at Rouen by 2 feet 3½ inches at spring-tides, and 1 foot 9½ inches at neaps; whilst the highwater level has remained unaltered. The tide reaches Rouen fifty-eight minutes earlier than formerly, namely about two and a quarter hours after high-water at Havre: whilst high water at Rouen occurs from five and a quarter to six and a quarter hours later than at Havre.

The training-walls have more than fulfilled the expectations of their effects on the depth of the channel between them; but their deepening influence extends very little beyond their extremities. Nevertheless, by bringing the deep channel of the river much nearer the sea, the intervening gap of shallow channel in the estuary is readily traversed at high water in fine weather. Moreover, owing to the greater range of tide in the lower estuary, the depth near high water in the navigable channel through the estuary approximates to that within the trained channel, so that little inconvenience would be felt from the absence of an improved depth between Berville and the sea if the estuary channel was stable (Plate 4, Fig. 2.) This channel, however, is constantly shifting, and though it is carefully marked by buoys, the changes cannot be immediately indicated during stormy weather, when the greatest alterations occur, and when a knowledge of the exact position of the channel is most urgently needed. Also in fogs, an altered channel, even though marked by buoys, is not readily discovered. Accordingly vessels incur considerable risk at times, and are occasionally wrecked in traversing the interval between the sea and Berville. The growing trade of Rouen, and the improvements in progress above, enhance the importance of a safe and easy channel between Rouen and the sea. The shiftings of the estuary channel can only be prevented by an extension of the training-walls, which would also increase the depth.

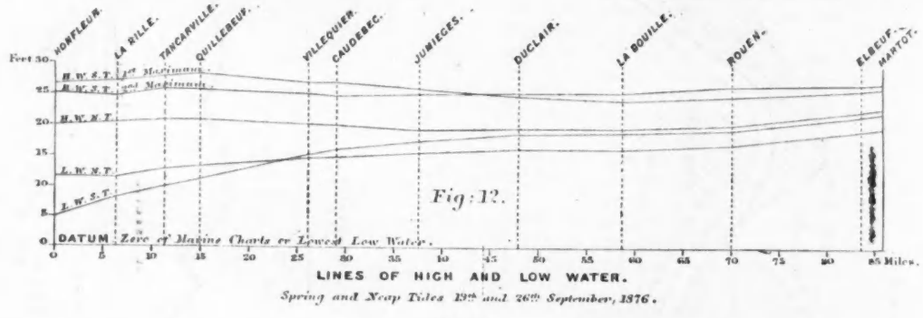


Fig: 12.

Plate 4.

The training-walls have been executed very nearly in accordance with the lines indicated by Mr. Bouniceau in 1845, but they have not been carried out to the extent he proposed. The author pointed out in his paper on "Harbors and Estuaries" that Mr. Bouniceau had considered accretion in the estuary as an extremely remote consequence of the training-works; whereas by the time the training-walls reached Tancarville and La Roque, the accretions had been so rapid and considerable that the walls were kept low beyond these points, and the works were finally stopped in 1870 for fear of endangering the approaches to Havre, the second port of France, by the silting-up of the estuary. A survey made by Mr. Estignard in 1875, showed that a loss of 272,000,000 cubic yards of capacity at high-water had occurred in the estuary, in spite of the increased volume within the limits of the trained channel, since the commencement of the works, an amount equivalent to nearly one-third of the total capacity of the estuary. Such a result excited so much anxiety about the maintenance of the estuary that another survey was made by Mr. Germain in 1880, from

Fig: 9.

PLAN OF ESTUARY 1883.

SHOWING SCHEMES FOR PROLONGATION OF TRAINING WALLS.

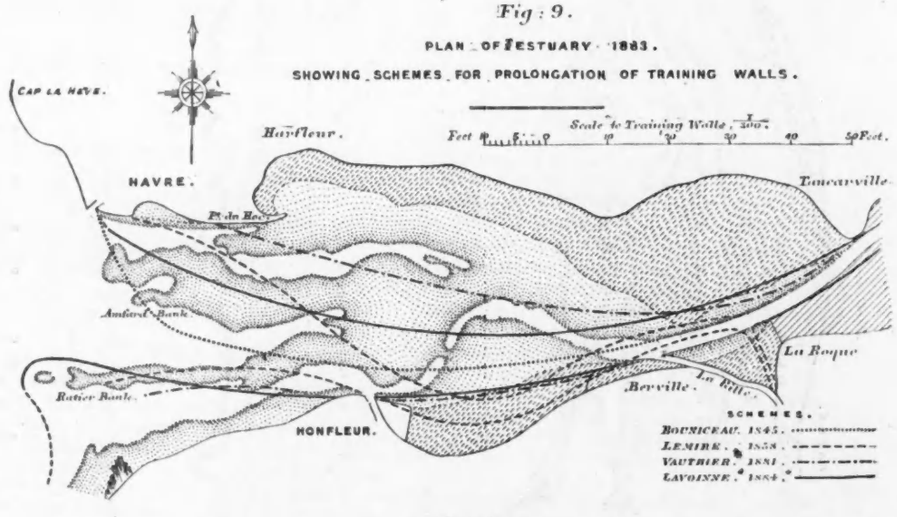


Plate 4.

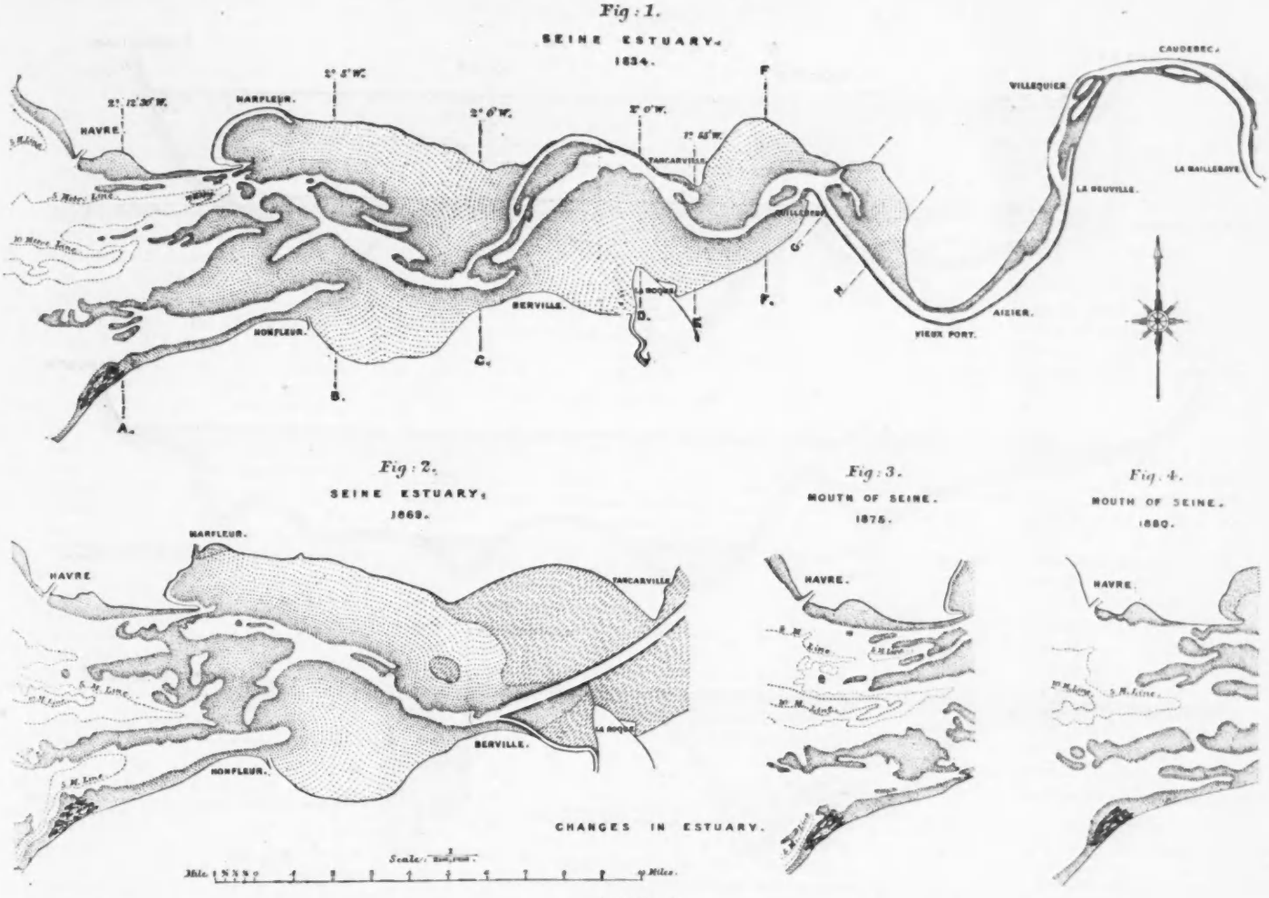


PLATE 5.

which it appeared that the capacity of the estuary had further decreased by 40,000,000 cubic yards in the five years from 1875 to 1880, making a total reduction of 312,000,000 cubic yards in the capacity of the estuary since the commencement of the works. This enormous accretion has enabled large tracts of land to be reclaimed, and altogether about 25,000 acres have been raised above high-water mark; some portions are only partially covered by very high tides, and the areas lying above Tancarville and La Roque have been completely reclaimed (Plate 4, Fig. 1). The value of the land when fully reclaimed is estimated at about £1,600,000, thus amounting to more than the expenditure on the works; but the Government have admitted the right of the riparian landowners to a share in these reclamations. The lands thus raised extend as far as Honfleur on the southern shore, and eight and a half miles beyond the ends of the training-walls on the north, which shows that the accreting influence of these walls extends far beyond their extremities.

The prolongation of the training-walls has naturally formed the subject of various designs; for whereas Rouen needs a stable and deeper entrance channel, it is essential that the training-works should both supply a channel for Honfleur on the south, and at the same time not divert the ebb and flow of the tide from the entrance to Havre on the north, either by deviating the deep-water channel towards the south, or by greatly restricting the estuary. The principal schemes are shown in Plate 4, Fig. 9; and the most important and latest of these is that of Mr. Lavoinne, propounded in his book on "La Seine Maritime" published in 1885 after his lamented decease. Having charge as engineer-in-chief of the tidal Seine from Rouen to the sea, and residing at Rouen, he necessarily was much interested in the development of that port by the formation of a satisfactory channel from Berville to the sea, a problem presenting peculiar difficulties and of the highest interest to engineers. It would be impossible to rest content with the present state of the outlet, where a narrow trained channel emerges abruptly into a wide shallow sandy estuary, resulting in a barred shifting channel beyond the ends of the banks, which is likely still further to deteriorate from accretion in the estuary. The difficulties consist in designing a line for the training-walls which shall serve both Honfleur and Havre, and in placing them close enough together to fix and deepen the channel without unduly reducing the tidal capacity of the estuary. Mr. Bouniceau planned a narrow winding channel passing close along Honfleur, and then directed out to sea with the northern bank turning up to Havre (Plate 4, Fig. 9), or an alternative scheme taking the trained channel across the estuary from Honfleur to Havre. Both schemes would have greatly restricted the estuary; and whilst the first scheme diverted the channel away from Havre, the second necessitated a sharp bend and a badly placed outlet.

Mr. Lemire proposed a narrow channel, like Mr. Bouniceau's, down to Honfleur, but more sinuous, though it expanded beyond to a trumpet-shaped mouth, an improvement in this respect on Mr. Bouniceau's scheme (Plate 4, Fig. 9.)

Mr. Vauthier, in his report to the municipality of Rouen in 1881, indicated the plan he advised for dealing with the estuary. It consists of two training-walls diverging to Havre on the north, and to Honfleur on the south, in continuation of the present channel which he proposed to widen out up to Quillebeuf, so that the widening out towards the sea might be more gradual (Plate 4, Fig. 9). A detached portion of wall near the Ratier Bank would prolong the southern training-wall to the sea, resembling in this feature Mr. Lemire's design. It has, however, been objected to Mr. Vauthier's scheme that his training-walls, being so far apart, and mainly on banks already considerably raised by accretion, would have little influence on the channel between them.

Mr. Lavoinne adopts a middle course between the previous schemes, for whilst interfering less with the estuary than Mr. Bouniceau or Mr. Lemire, he places his walls much closer together than Mr. Vauthier, though proposing the same modifications of the existing walls between Quillebeuf and Berville (Plate 4, Fig. 9). Before entering upon the consideration of his scheme, Mr. Lavoinne discusses in his book the results of the hydrographical surveys of Mr. Estignard and Mr. Germain, and the modifications in the tides at Havre observed by Mr. Quinette de Rochemont, M. Inst. C. E., and attributed by that engineer to the silting-up of the estuary. The time of high-water at Havre has advanced thirty-eight minutes; and the reverse current, which makes its appearance near Havre some time before high water, has also advanced about thirty minutes. Mr. Lavoinne considers that this change is due to the increase in depth seawards of Havre, and not to the influence of the diminished capacity of the estuary. Whilst, however, it is possible that the increase in depth has somewhat facilitated the approach of the tide to Havre, it is difficult to admit that an advance of the lines of soundings of which the maximum is 400 yards should have effected such a notable advance in the period of the tide, and

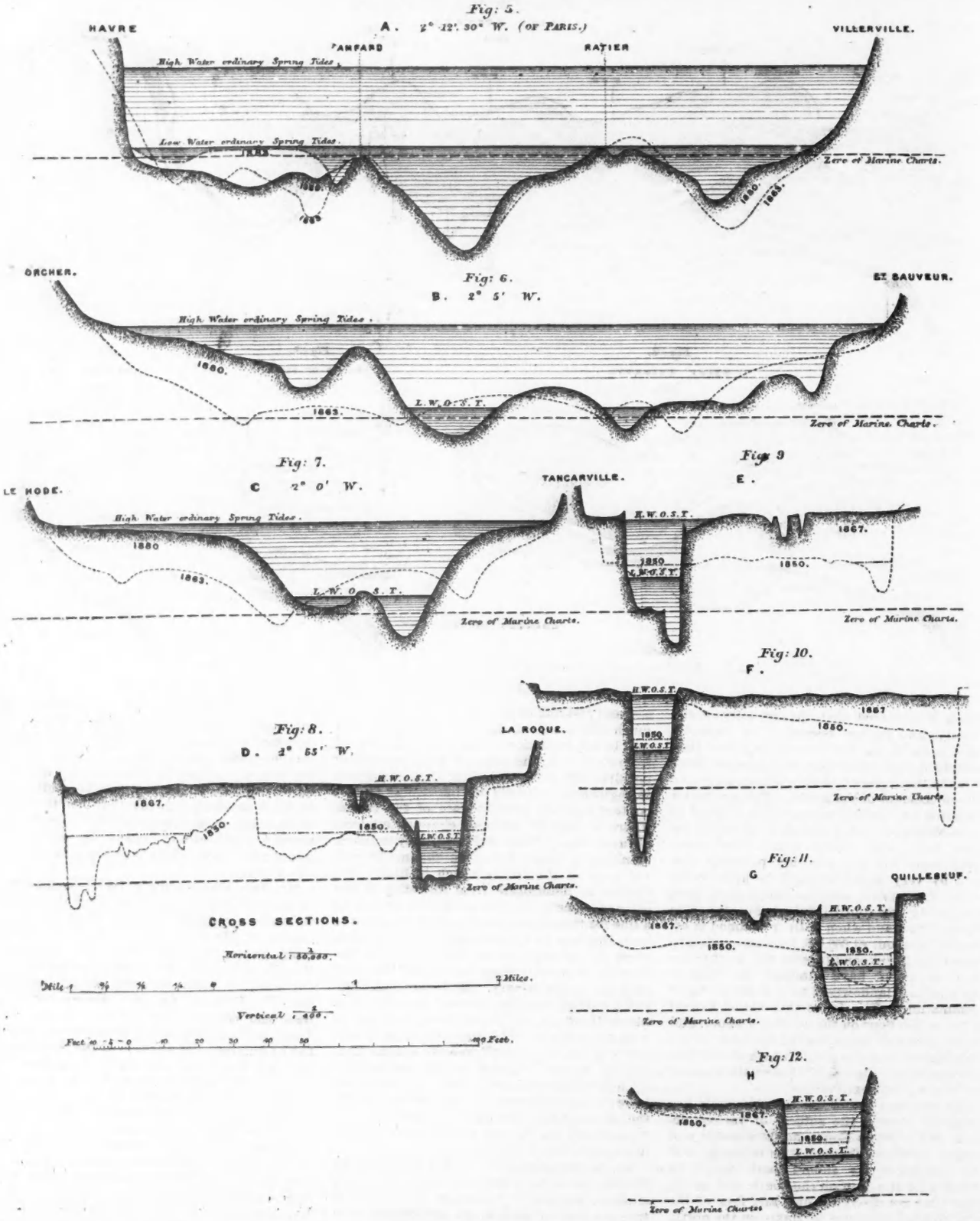


PLATE. 5

that the great diminution in the capacity of the estuary has had no influence on the result. It is far more probable that both causes have contributed to the change, but in what proportions it would be very difficult to determine, though the author thinks that the preponderating influence must be due to the very great alteration in the estuary produced by the training-walls. As, however, Mr. Lavoinne attributes the deepening in front of Havre to the training-works, the question is one rather of scientific interest than of importance with regard to the future of the estuary, for, according both of Mr. Lavoinne's and Mr. de Rochemont's views, an extension of the training-walls would occasion further modifications in the tidal regime.

Mr. Lavoinne's remarks on the vibrations in depth, deduced from the hydrographican surveys, are of much greater importance in the consideration of the improvement of the

estuary-channel. He points out that great changes have occurred at the mouth of the estuary in the past as well as recently, and that thirty-two years ago the capacity of the estuary, between the meridians of Honfleur and Cap de la Hève, was actually less than at present, though Mr. Germain's survey indicated a considerable accumulation in the deep water channels between 1875 and 1880. He attributes these changes to the variable action of storms, rather than to the regular ebb and flow of the tide. The author agrees with these views as regards the outer portion of the estuary, for the increase in depth has occurred at depths where waves would exert far more influence than the tidal flow, and the changes have been so very irregular (Plate 5, Figs. 1 to 4). Moreover, although Mr. Germain discovered that the deep passes had shoaled between 1875 and 1880 (Plate 5, Figs. 3 and 4), he found that there was some increase in capacity in the section above, which would be more subject to the influence of the decrease in tidal-capacity. Mr. Lavoinne, however, appears to go a step further, and to the result of a period of storms, tending to reargue that the great silting-up in the estuary is move the sands from outside, and to deposit them within the estuary. Accordingly, Mr. Lavoinne is at issue with Mr. Estignard as to the cause of the deposits in the estuary; for the former attributes them mainly to a succession of peculiar meteorological conditions favoring deposit, which might be succeeded by a series of reverse phenomena as previously, though admitting that the training-walls have somewhat aided the deposits by their shelter; whilst the latter considers the accretion to be wholly due to the training-walls. The author thinks that the construction of the training-walls may have coincided with a series of peculiarly unfavorable meteorological conditions, which has hastened the accretion in the estuary; but the training-walls, by totally altering the condition of the estuary, have undoubtedly permanently fixed the deposits both behind them and in the sheltered bays in front, so that a recurrence of favorable conditions would no longer, as of old, clear out the estuary. The wanderings of the channels have been restricted, from the ends of the training-walls to a line between Honfleur and La Hoc, by the land which has been raised beyond the influence of the tides, so that the reductions in the estuary are permanent (Plate 5, Figs. 1 and 2; and Plate 4, Figs. 1 and 8).

It is, moreover, probably that the considerable increase in capacity of the outer estuary, which occurred between 1853 and 1875, may have been due to the sand and silt, brought up by the waves and flood-tide, having been deposited behind the training-walls, and having thus been prevented from being carried out again by the ebb-tide, and redeposited in the lower estuary; for this period of erosion in the outer estuary approximately coincides with the period during which the training-walls exercised their greatest influence in promoting the enormous accretions measured by Mr. Estignard. Mr. Lavoinne has overlooked this possibility, and has considered the changes as due entirely to meteorological oscillations, and quite uninfluenced by the convulsion which has occurred in the upper estuary in consequence of the training-work.

Mr. Lavoinne's scheme serves Honfleur by placing the southern concave training-wall close alongside it. The mouth of the estuary is also narrowed by prolonging the southern wall across the existing southern channel, and all along the Ratier Bank (Plate 4, Fig. 9.) Besides narrowing the limits of the tidal flow, Mr. Lavoinne anticipates a benefit to the estuary by cutting off the southern channel, up which the tide brings a good deal of silt, whereas the middle and northern channels are tolerably clear; and considers that, by keeping the walls low, the accumulation of deposit behind them will be prevented or delayed. The experience, however, derived from the low banks beyond Tancarville and La Roque affords little hope of such a result.

The author, whilst acknowledging the great ability displayed by Mr. Lavoinne in his discussion of the subject, and in the scheme he has advised, and whilst agreeing with some of the points urged in favor of the scheme, nevertheless considers that there are important objections to some parts of the proposal. He has already, in his paper on "Harbors and Estuaries," expressed full concurrence with the proposed widening out of the existing training-walls, first propounded by Mr. Vauthier; and he adheres to the view that it would be very advantageous if such widening could be extended still higher up, so that the tide might be more freely admitted, and that the widening out towards the mouth of the estuary might be more gradual. He considers, however, that the continuously concave southern training-wall, whilst very favorable to Honfleur, will unduly keep the ebb current to that side, and therefore away from Havre. Also he thinks that the extension of the wall along the Ratier Bank will act like a groyne, and, arresting the silt-bearing southern current, will connect Trouville Bank with the shore, and lead to a large accumulation of deposit in front of Trouville. Moreover, he is of opinion that the exposed position of the wall on shifting sand banks will render its maintenance very difficult till deposit has accumulated behind it, and also that the low walls proposed will not prevent accretion.

The channel just below the training-walls is influenced by the ebbing current issuing from the trained channel till it gradually loses its effect; the outer channels are formed by the flood-tide, and modified by the action of storms. Between these channels, there is a zone in the estuary where the flood and the ebb have varying influences, resulting in a continually shifting channel (Plate 5, Fig. 2; and Plate 4, Fig. 1 and 8.) In order to improve this central portion of channel, it is necessary to make the ebb act more directly upon it, and as far as possible to concentrate the flood in the same direction. This necessitates the restriction of this portion of the estuary by training-walls, and the author has given in Plate 4, Fig. 8, the direction for the walls which he believes would accomplish the desired result. He has retained the enlargement in width of the existing trained channel, as advocated by Mr. Vauthier and Mr. Lavoinne, but with the proviso that he would much wish to extend it further up if it was possible. He has dispensed with the continuous curve by narrowing the width slightly more than Mr. Lavoinne at the change of curvature, and by forming a short channel of access to Honfleur, which could be very easily maintained by dredging. This will enable the channel to be carried more directly towards the position of the central deep, and more over towards Havre. He has only placed a regulating wall beyond Honfleur, as he considers that the flood should be freely admitted by all three channels, and concentrated by the funnel-shaped mouth towards Honfleur, where the ebb would be losing its influence. The southern training-wall would not be prejudicial to Troville; and the northern training-wall would be sheltered from north-westerly storms, and would be soon protected by accretion at the back. The tidal capacity of the estuary will undoubtedly be still further reduced; but by prolonging the influence of the ebb, which is powerfully reinforced by the large discharge of clear fresh water from the Seine, and by bringing the trained channel down to the place where deep water is maintained by the flood-tide and the action of waves, it may reasonably be anticipated that a stable and adequately deep channel will be secured, which will provide a proper access to Rouen without injury either to Havre or to Honfleur.

The Tancarville Canal is in course of construction for the purpose of enabling smaller vessels to pass between Havre and the trained channel without encountering the dangers of the exposed estuary (Plate 4, Fig. 1). Formerly a channel existed along the northern shore, under the shelter of Hoc Point, by which small vessels could reach the estuary above; but the site of this channel has been converted into land by the accretions. The canal extends from the docks at Havre to the trained channel at Tancarville; and the locks and other works of construction on it are being made large enough to admit of the passage of sea-going vessels from Havre to the river at Tancarville, by merely excavating an enlarged section for the canal in the event of such a deterioration of the estuary as to bar the river channel. The author, however, thinks that the necessity for a ship-canal between Havre and Tancarville may be obviated by judiciously-designed training-works, aided by the large fresh water discharge of the Seine, and the deep water outside.

PUBLICATIONS RECEIVED.

Tables for the Computation of Railway and other Earth-work, computed by C. L. CRANDALL, C. E. Ithaca, N. Y., Andrus & Church, 1886. Price, $1.

This volume, although containing only twelve pages of text and fifteen pages of tables, we believe to be one whichis destined to make an epoch in methods of computing earthwork, and one which will exert a great influence in causing all methods to finally rest on the only true and proper basis, that of the prismoidal formula.

The plan adopted by the author is that of triangular prisms, which was first introduced, as far as we know, in Wellington's Computation of Earthwork by Diagrams, and some of the advantages of which were there explained. This method consists in producing the slopes of an excavation until they meet at a vertical distance d below the roadbed; then if c be the center cut and w the horizontal distance between slope stakes, the area of the triangular prism is $\frac{1}{2}w(c+d)$. The quantities w and $c+d$ may be thus made the arguments of a table or diagram for finding the solidity in cubic yards, from which the solidity of the triangular grade prism is then subtracted. The table is hence independent of side slopes or width of roadbed, and is applicable to borrow pit cuttings as well as to all varieties of excavation and embankment.

Mr. Wellington's diagram of triangular prisms gives solidities for heights up to 18 feet and for widths from 8 to 88 feet. To tabulate this to tenths of each dimension, would require, as he supposes, $180 \times 800 = 144{,}000$ quantities, equal to 200 pages or more of print, which would be impracticable. Mr. Crandall, however, has succeeded in constructing a table, occupying only seven pages, which gives solidities for heights up to 50 feet and widths to 100 feet. This is done by tabulating the quantities for single feet, and on the margins giving corrections to be added for the tenths both of height and width. By this ingenious device the capacity of each tabulated solidity is increased ninety-nine fold, while the greatest error due to the arrangement is rarely two cubic yards and usually only one cubic yard for a prism 100 feet in length.

The tables of the volume are two in number, the first a table of triangular prisms to be used by the method of averaging end-areas, and the second a table of corrections to be applied in order to reduce the first solidities to the true prismoidal contents. This method seems very illogical, as we said editorally a few weeks ago. The fact is that the second table of the author might properly have been called a table for computation by the prismoidal formula, for by it, without using the first table at all, the true prismoidal contents of any earthwork solid may be ascertained. It is likewise applicable to fine-level ground and irregular sections in general by using the proper arguments.

While it does not appear from the text that the author recognizes the full value and scope of the tables, and although the explanations are not usually as clear as might have been, Prof. Crandall is to be congratulated on having published a work which we think is destined to exert a great influence and which will prove of great value to railroad engineers.

ENGINEERING NEWS

AND

AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

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We publish this week a double page illustration of the Harlem River Draw Bridge connecting the Suburban Rapid Transit R. R. with the Elevated R. R. System of this city. Very complete details, and description will be published hereafter. Every copy of ENGINEERING NEWS *should have this illustration this week.*

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THE property of the Denver and Rio Grande R. R. Co., was sold under foreclosure on the 12th for $15,000,000; the sale was in the interest of the bond and stockholders under the reorganization plan, and the property will be reorganized at once under the old name.

WHEN we published the address of Col. Henry Flad two weeks ago it was in an exceedingly hurried way and after our regular forms had been made up. It was not paged for indexing and we therefore reprint it entire this week, together with full list of members and visitors in attendance at the Convention at Denver, received from official sources.

The Convention party is mostly all again at their homes, fatigued of course, after such a journey and the hospitalities incident to it, but pleased with the splendid trip and the most gratifying reception accorded to them everywhere. Such report as we may make will come in time, when our correspondent is able to gather up the threads that have been unreeled so rapidly in the two weeks past.

READERS of ENGINEERING NEWS will please to note the addition of four pages of reading matter made with the beginning of present volume, July 3. These pages are inserted among the advertising sheets for several reasons. The published matter is exclusively of a transient value being made up of news items: they enhance the value of all the advertising pages; they lessen the labor of semi-yearly indexing, and they allow space in the body of the paper to be used for matter of more permanent value. Readers will therefore see to it that they look through carefully, *every page* of ENGINEERING NEWS, if they would be certain of getting at all its value. This will not involve any more time than heretofore, and as we expect to add continually to the *news* department it may as well "be got used to."

How may a publisher best accommodate all his patrons—subscribers and advertisers. Both are absolutely essential to the existence of the property, and the interests of all must be carefully watched and cared for. Each subscriber wants his "specialty" voluminously treated and some grumble at the apparent preference of one subject to another. Every advertiser would like to be at the top of the page and opposite the reading pages, and yet buy the privilege at the very lowest rate. Between the eagerness of agents to secure their commission, and the inelasticity of "reading pages" and "tops" publishers have sometimes been crowded into embarassing situations, release from which came only by the disagreeable necessity of losing the advertiser altogether. Some journals are a "hodge-podge" of advertisements and reading pages and, sad though the admission be, these unattractive sheets present the most prosperous appearance; the business public do not seem to appreciate the purely esthetic side of the question, but if they can have plenty of "tops" and "opposites," the permanent literary value of the "medium" is of small account.

ENGINEERING NEWS, does not complain. The policy from the very first has been to create a value for itself as a record of engineering in America, independent of its advertising patronage. If it could succeed in attracting interested readers and hold them in increasing numbers and influence year after year, then its value to advertisers would prove itself. In this we have succeeded. Our readers will bear witness to the steady development from the meagre publication of 1876 to the healthy issue of to-day. We now give *more engineering news* than any single engineering newspaper *in the world*, (no exceptions and no qualifications), and of the two great English journals, we give as many pages of reading as the *Engineer*, and leaving out the columns of patent office specifications, more than either the *Engineer* or *Engineering*. These papers sell at $10 a year each, and they carry between 50 and 60 pages of advertisements each week: in the matter of illustrations we are rapidly overtaking them and long before the time when we have the revenues from *one half* of their present advertising patronage, we will surpass them in not only the item of copious illustration, but in variety and value of current news of the world, in descriptions of important engineering works, and in all that gives value to a great and influential Engineering newspaper. This is inevitable; America is great in engineering works as in breadth of territory, and nothing less than *the* engineering newspaper of the globe will satisfy the profession that is to build the works that are to develop—not the coming, but the now present—greatest, richest and best country and people that the sun shines on.

IN *Bradstreet's* of July 10th, is a long letter from a special correspondent on the "Street Railway Companies of Berlin" giving a list of street railways, their cost, revenues, lengths, method of working, legal requirements of companies, wages paid, etc. etc., making very interesting reading for parties engaged in building or managing this class of property. We note only in reference to the employés: the pay, besides their uniform is $240 a year; twelve to fourteen hours makes a day; allowing one day each week free; conductors get "tips" amounting to as much as $1.00 a day in case of the most obliging ones, part of which goes to the driver; superintendents get $1.50 per day, free lodgings and uniform; stablemen get 75 cents; at Christmas each, in accordance with length of service with company, gets a present of half or a whole month's wages; at death, or in case of illness or accident, the men and families are provided for according to the German legal requirements.

THE men who took practical possession of the Dominion Government, and of the chief monetary institution of that country, interested great capitalists in Europe, and through sumptuary legislation and strong financial backing, built the Canadian Pacific Railway system in spite of the obstacles of distance, climate, unpopulated wastes, and great mountains, are men who have no superiors in wide intelligence, broad views of commerce, and first rate executive abilities. This syndicate of leading spirits will eventually control every mile of Canadian railway, and, aided by the spirit of English prejudice for its colonial empire and against the encroaching powerful Republic alongside, they will, without doubt, become a controlling factor, in the great problem of trans-continental transportation. The Canadian Pacific R. R. is now open throughout its entire length; the road bed is reported to be in fair condition, and the speed and regularity of train service will be the best proof of this; the rolling stock is probably the best on the continent; low rates are announced; novelties of all kinds are being introduced, and the management are showing a consideration for their patrons as yet unknown to American railroads. These attentions to the comfort of the class which will use this northern route, are probably an absolute necessity on account of the scanty and wretched accommodations of the country traversed, but nevertheless they show originality, and smack of enterprise, qualities which heretofore have not usually been conceded as characteristic of our slow going brethren across the border.

A LATE issue of *Herapath's Journal* takes a very pessimistic view of the future of the Canadian Pacific Railroad, predicting that at the conclusion of the seven and one-half years during which a dividend of 3 per cent. is guaranteed the stock will be relegated to that large and increasing class of investments existing only for speculative purposes.

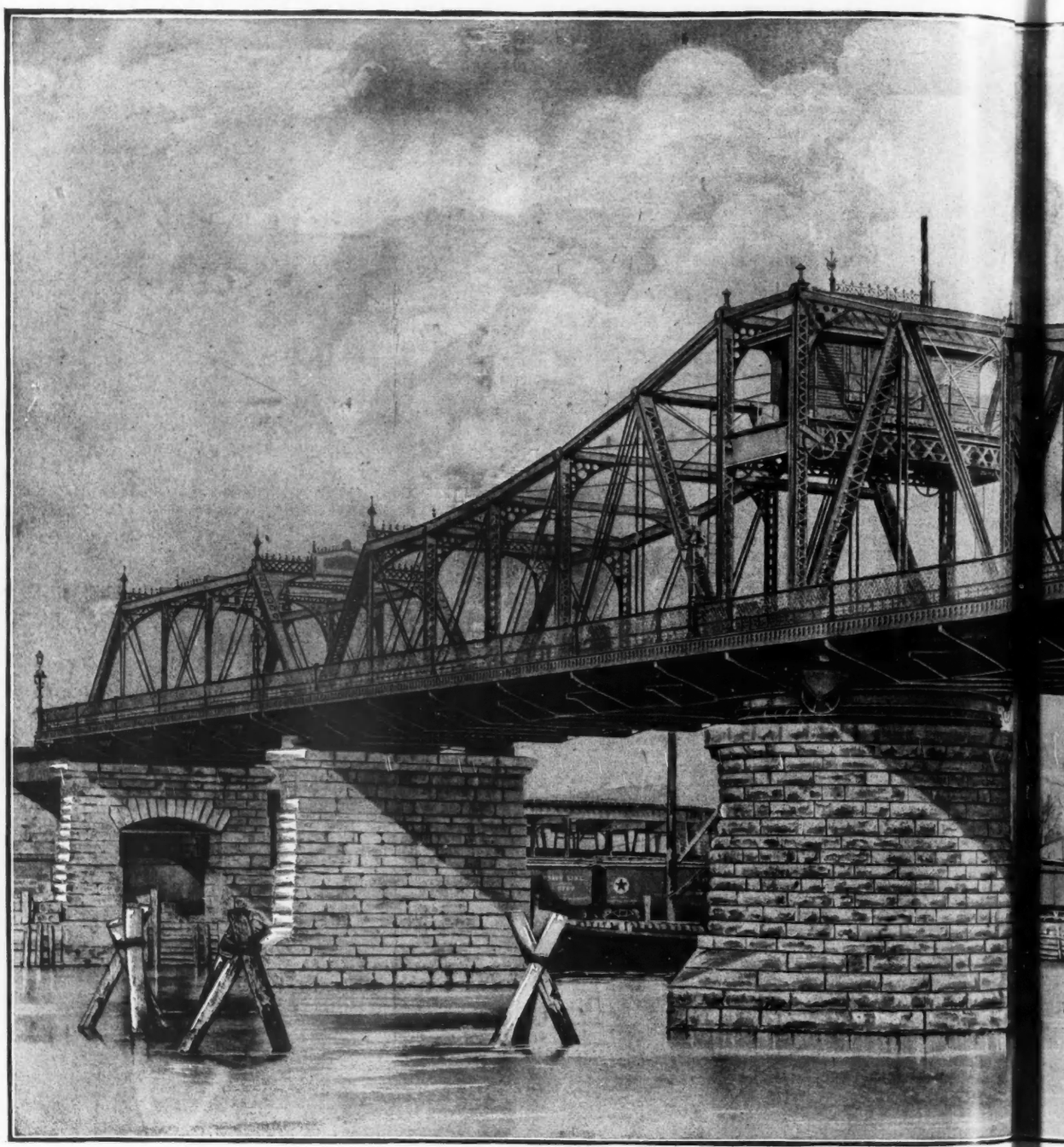
The proposed steamer lines are objected to as not likely to be profitable even with the aid of a Government subsidy; asserting that mails alone do not pay and asking "would passengers travel by a route frozen for a considerable portion of the year?

We think decidedly that they *would not* if the Canadians used the same appliances for heating their cars that the English do, but notwithstanding the fact that it *is* liable to freeze on that route, the editor of our esteemed cotemporary would probably grumble more at the heat of the cars, than at the frost outside, if he had occasion to travel over the road in winter.

J. J. R. CROES,
Chief Engineer.

DESIGNED BY THEODORE COOPER,
Consulting Engineer.

ENGINEERING NEWS, JULY 17TH, 1886.



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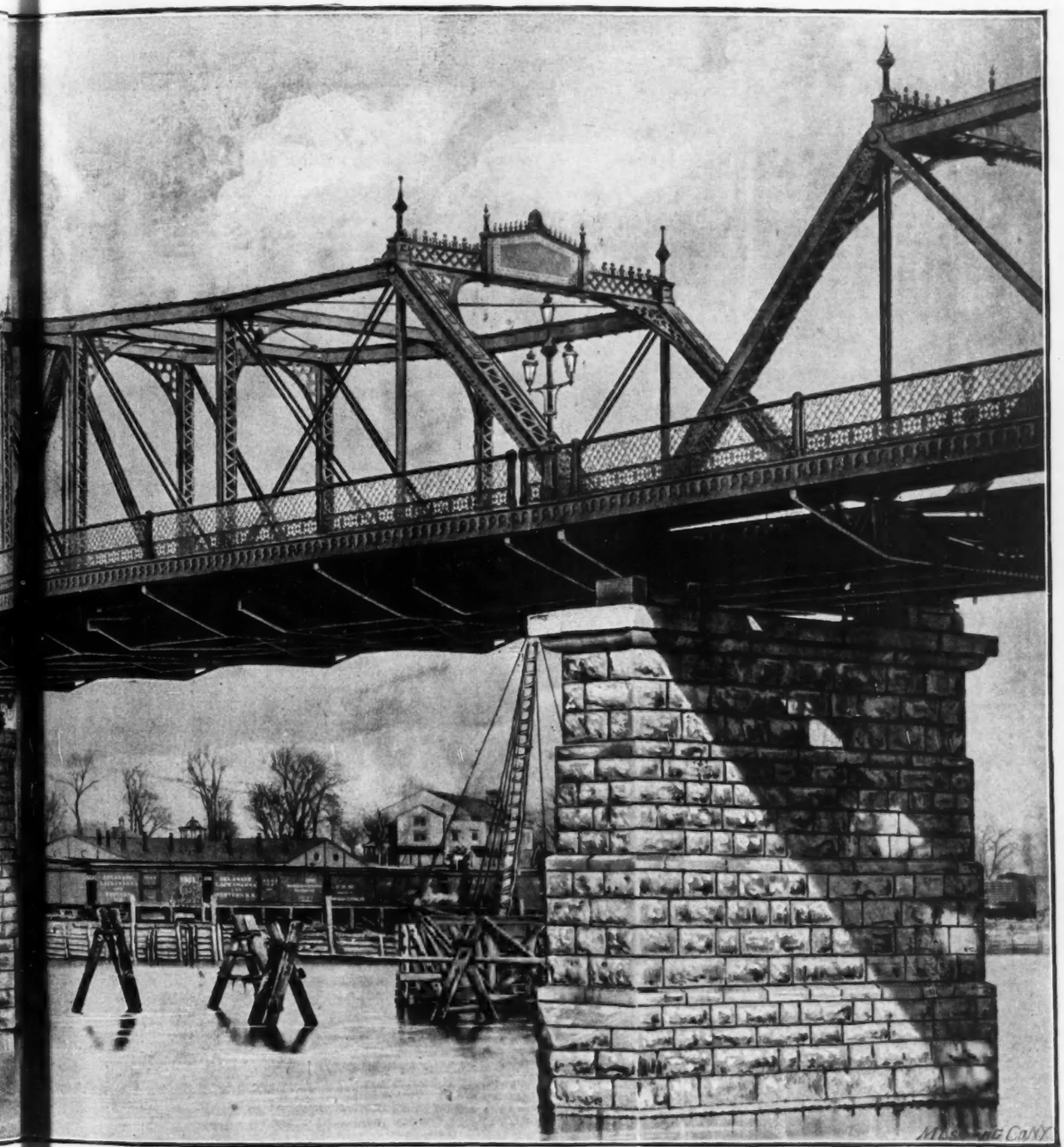

RAW BRIDGE.

ID ANSIT COMPANY.

Public Works Commissioner R. M. Squire is the most "cussed" as well as discussed, man in journalistic and political New York circles this week. Some months ago, as he alleges, he directed his First Assistant, to reconnoitre the offices of his department with a view to retrenchment, and as a result, this week there have been dismissals by the wholesale. How much of this zeal is inspired by a desire to subserve the public interests, and how much to strengthen Mr. Squire's political party, only the men who pull the strings that make the puppets dance, can tell. It is noted by a daily journal that all the dismissals have been from the ranks of the "County Democracy."

In addition to this trifling *divertissement* of the rampant Commissioner, he has on hand a little legal set-to with Commissioner of Accounts Shearman, and apparently is on top, although according to the reports in the dailies the autocrat of the city bill books is credited with portentous "smiles" and "shrugs" and wise "uplifting of eyes" in reply to the pestiferous insects of the daily press who are constantly buzzing about him. Let the best dog win!

Mayor Harrison of Chicago on the 12th, vetoed the ordinance giving the use of the La Salle street tunnel to the North Chicago Street Railway Co., and no attempt was made to pass the ordinance over the veto. The veto submits a counter ordinance demanding $25,000 rental for the tunnel, instead of $20,000; or that the railway company shall build a double track steel bridge at Clark street and pay $10,000 yearly for the tunnel; or if the company will build still another similar bridge at Wells street, the annual rental will be considered as paid in full. As to the improvements in the tunnel for the benefit of pedestrians and teams demanded in the first ordinance, they are still required in the second.

The Chicago newspapers set up a fierce howl over the "steal" of the old tunnel in question. Probably the railway company offered about all the thing was worth, or very nearly so. The tunnel paid for itself many times over in the couple of years following the great fire of 1871, when it was the chief artery of travel between the North and South sides of the city. But in the last few years it has, along with the Washington street bore, largely fallen into a state of "innocuous desuetude" and in reality the emaciated finance department of the Garden City is just so much ahead by the offer of the railway company. Keeping out the dirty water of the river overhead, and repairing the chronically dilapidated roadway would be loaded off on the company's treasury instead of being borne by the city. It is within the region of probability, that, if the company back out altogether, before long they would be offered the now over-rated privilege rent free, if they would keep the hole open and fit for safe travel.

Bradstreets of last week has an article on the building of the New Jersey Junction Railroad i. e. the line from Weehawken to Communipaw, of which Mr. Katté' is chief engineer, which it heads "a West Shore Extension." The theory is that as the New Jersey Central, Pennsylvania, Lackawanna, Erie & West Shore roads have acquired nearly all the water front from Weehawken to below Communipaw, the Vanderbilt roads, backed by the Pennsylvania are to turn the Junction Road, which was apparently projected to facilitate freight transfer between the various roads mentioned above, into a continuation of their through freight line, and crossing the Kill von Kull build up a shipping port for foreign and coastwise freight on the south side of Staten Island.

It is not impossible that the examinations lately made for a tunnel under the river opposite Spuyten Duyvil may have something to do with this scheme—if it is a scheme.

The New Harlem Bridge.

The long pending contract for the new bridge over the Harlem river at 181st street, was awarded by the Commissioners on Wednesday, to the Passaic Rolling Mill Co., for $2,055,000, the other bids being the Union Bridge Co., $2,058,000, and the New Jersey Steel and Iron Co., $2,215,000. The masonry is the contract of Myles Tierney, at $1,210,000, the iron work contract being $845,000. There were ten bids for masonry and five for iron work. The bid of Mr. Tierney was what secured the contract. He is the contractor who built most of the foundations for the pillars of the elevated railroads in this city, and has been identified with many other important building contracts. He is possessed of an enviable bank account. The Passaic Rolling Mill Company supplied a large part of the iron work of the elevated roads here and in Brooklyn, and has built some of the largest railroad bridges in North and South America.

The construction of the bridge will be begun at once, and the structure is to be ready to be opened to traffic on June 28, 1888.

No changes have been made in the design which was originally adopted by the commission, though some minor modifications may be found necessary in the masonry work, in consequence of the greater depth to which the piers will have to be sunk. The foundation of the main pier will be 24 feet deeper than the original specifications stated, and it may yet be found necessary to deepen the foundations of all the other piers. According to the design adopted, which is a modification made by William McAlpine from the first and second prize designs submitted to the commission, the new bridge will extend over the Harlem river from Tenth avenue and One Hundred and Eighty-first street, on the west side, to Aqueduct avenue, on the east side, a distance of 2,373 feet. The first 355 feet, however, from Tenth avenue, will be simply grading. The total width of the bridge will be 80 feet, of which fifty feet will be carriageway, and 30 feet, divided into 15 feet on each side of the carriageway, will be sidewalk. The floor will be 145 feet above mean high-water mark. From a central stone pier, 40 feet thick, will spring on both sides a steel and iron arch 508 feet long, with a rise of 90 feet. The land end of one arch will rest upon a pier on the west bank of the river, and the end of the other arch, which will span the railroad track, Commerce avenue and Sedgwick avenue, will rest on another pier back from the river, east of Sedgwick avenue. The two masonry sections will be alike, though not of equal length. That on the west side is to be 277 feet long, and that on the east, 342 feet long. The masonry portions will be almost entirely of Westchester gneiss.

The authority of the Commissioners is unlimited. They can, if they choose, build a twenty million dollar bridge, and do it by the day's work.

Earthwork Computation by the Prismoidal Formula.

Recently we took occasion to call attention to the illogical method of computing the earthwork solids of railroad excavation and embankment followed by many authors. The prismoidal rule, they recognize, gives the correct contents, but instead of proceeding to use it, they first compute the solidity by the incorrect method of average end areas, and then derive a correction to be subtracted from that solidity to obtain the true contents. We now purpose to point out how by means of Wellington's diagram of prismoidal corrections or Crandall's table of prismoidal corrections, the true solidity may be obtained in a more expeditious manner than by the illogical method, and without using at all the diagram or table for the solidity by end areas.

As the use of a diagram is essentially the same as that of a table, we will refer only to the latter, and for the purpose of illustration give the following abridgement of a portion of Crandall's table, in which the numbers in the left hand column and those at the top of the other columns are distances in feet, while the other quantities are solidities in cubic yards for a prismoid 100 feet in length. The numbers in feet are called the arguments of the table.

	25	26	27	28	29
31	239	249	258	268	277
32	247	257	267	277	286
33	255	265	275	285	295
34	263	273	283	294	304
35	270	281	292	302	313
36	278	289	300	311	322
37	285	297	308	319	331
38	293	305	317	328	340
39	301	313	325	337	349
40	309	321	333	346	358

Let c and c' be the center cuts or fills at the two adjacent sections, and let w and w' be the corresponding horizontal distances between slope stakes. Let b be the width of roadbed. Let d be half the width of roadbed divided by the side slope ratio. Let the sum of c and c' be denoted by a. Then the following is a rule for finding the prismoidal content of a solid 100 feet in length between the stations:

Enter the table with the arguments $a + c$ and w, and find a solidity. Enter again with $a + c'$ and w', and find a solidity. Enter again with $w + w' - 2b$ and $3d$, for a solidity. The sum of these three solidities is the number of cubic yards in the prismoid according to the prismoidal formula.

For example, let the roadbed be 18 feet and the side slopes 1 to 1. Let the center cut at the first station be 7 feet, and the width between slope stakes 33 feet, and let the same quantities for the second station be 11 feet and 39 feet respectively. Then $a = 18$ feet, and $d = 9$ feet, $a + c = 25$ and $w = 33$, $a + c' = 29$ and $w' = 39$, $w + w' - 2b = 36$ and $3d = 27$. For the arguments 25 and 33, the table gives the solidity 255 cubic yards. For the arguments 29 and 39, it gives 349 cubic yards. Lastly for 36 and 27, it gives 300 cubic yards. The sum of 255, 349 and 300 is 904 cubic yards, which is the true content of the solid according to the prismoidal formula.

To solve this problem by the method of average end area minus a correction, requires the use of two tables, three entries being made in the first and one in the second. It thus appears that by the help of a single proper table, the strict computation of earthwork according to the prismoidal formula is not only no longer, but is actually shorter than the computation by the illogical method. It will be understood, of course, that while the above numerical example and table are given only to even feet, the same principles and method apply when the data are given to tenths of feet and when a working table or diagram is employed.

Russian Harbor Improvements.—The sum of 16,000,000 rubles has been set apart for improving ports on the Black Sea and Sea of Azof to enable them to admit the largest Russian iron-clads.

Chief Engineer Church.

THE report of the examining engineers, Generals Newton, Greene and Gillmore in the case of Henry S. Craven against Benjamin S. Church, Chief Engineer of the New Croton Aqueduct was made this week and, as was confidently expected, completely exonerated Mr. Church. The committee made a thorough examination of all the charges presented, of the work under construction and of the engineering management.

The charge that the rubble stone masonry at the Saw Mill river crossing of the new aqueduct is not good was not substantiated. The report says:

The attempt to prove the bad, insufficient character of the masonry of this wall so entirely failed that the examining engineers find no difficulty in dismissing the implication in the charge that Chief Engineer Church neglected his duty by accepting the wall. The wall is shown from the testimony to have been built of strong and suitable materials, both as respects stone and mortar, and also to be in conformity to the specifications of the contract in materials and workmanship.

Mr. Craven's action in concealing from Mr. Church the reports of his assistants that the wall was not being built in conformity with the specifications is severely condemned.

The charge that Contractors O'Brien and Clark have not withdrawn timbering from the roof of the tunnel or filled in the space with stones, but have filled in the space with logs and timber, thereby endangering the masonry of the aqueduct, the committee do not find well founded. They say that to have removed the timbering would have been dangerous to those employed, and would have brought down loose rock on the fresh masonry, to its probable injury. They add that it is not probable that the timber will decay, owing to its exposure to constant wetting, but should decay take place, the masonry before that time will have acquired sufficient strength to support any weight which will come on it. The timber on the sides of the tunnels below the water surface in the aqueduct will always be wet and will not decay. The committee therefore acquit the chief engineer of any fault alleged in this particular.

Another charge was that timber once paid for as excavation was again measured and paid for as rubble-stone masonry. The timbering referred to is on sections 8 and 9. This is declared by the committee to be a mere quibble. The contract provides that under certain circumstances the timber work shall be left in and all cavities about it shall be filled with masonry or with such other material as the chief engineer may order. The space occupied by the timber was included in the estimate for masonry, and the spaces thus included and counted as masonry do not compensate the contractor for the increased expense of working around these timbers, which under the conditions fulfil the duty of masonry. The committee think that the decision of the chief engineer was just, conformable to custom and entirely correct.

Saving Eighty Per Cent. of Coal.

From the London Truth.

There has been of late so much alarmist talk about the exhaustion of our coal fields that it is good news to learn that an inventor, Mr. R. M. Marchant, has at last perfected an engine in which the steam is returned to the boiler and, so to say, used over and over again. The saving in coal thus to be effected is calculated at 80 per cent. Besides saving coal, however, this invention will upset a pet theory of the engineering fraternity, who have always considered this problem as impossible as perpetual motion.

PERSONAL

MR. ROBERT WALKER, C. E. F. R. G. S. a well known Civil Engineer of London, England, is in the city—he is the inventor and patentee of the Hydro-Carbon Furnace and apparatus, a description of which we will publish hereafter.

W. H. V. REIMER has been appointed to the newly created office of Township Engineer of East Orange, N. J.

At the meeting of the Engineer's Club of Philadelphia June 19th, the following were elected members: *Active*: Messrs. J. S. Walker, Hiram J. Slifer, Richard B. Osborne, G. L. Jones, Geo. Henderson and B. H. Wright; *Associate*: Mr. E.V. Douglass.

The contract for the Harlem River Bridge at 181st street was executed on Thursday. It binds the Passaic Rolling Mill Company and Myles Tierney to complete the bridge by June 28, 1888, under a bond of $400,000. Among the bondsmen are Benjamin G. Clarke, of No. 52 Wall street, and D. B. Fayerweather, of No. 2 Spruce street.

One Year of Engineering Progress.*

The field of engineering science has of late years become so extensive, that the task imposed on your President of giving a summary of engineering progress during the year is one of considerable magnitude. To make such a summary exhaustive, the records of all civilized countries would have to be searched, and the merits of new methods and appliances carefully weighed; so that only those which have proved or given promise of real value may be brought to your notice.

But it would be impracticable, within the limits of this address, to even enumerate all the important engineering works commenced or completed during the year; and to present simply a statement, giving the dimensions and cost of such works, would be of slight interest or benefit to the members of the Society.

I have, therefore, concluded that it would be preferable that I should mention the most important works only, and devote a portion of this address to a statement of my individual views on such other matters as I judge to be for the well-being and progress of the profession. Even if some of my views should be shared by but few of those present, no harm can ensue, as, very properly, the Society is not responsible for the individual opinions of its members. Furthermore, a departure from precedent to this extent, from what may be termed the strict construction of the by-laws, will doubtless lead to more general consideration of the subjects to which I refer.

There is another point on which I propose to depart from the beaten path. Instead of giving the greatest prominence to those works of the engineer which never fail to excite general admiration by being either the largest or the most difficult, or perhaps the most expensive, I propose to give the first consideration to that part of the work of the engineer which more directly influences the health and comfort of the human race.

I will, therefore, commence by referring to municipal engineering, by which I mean those branches of engineering which provide abundant and pure water, good streets and safe buildings, and which keep pestilence from our dwellings by providing for the prompt removal of all offal and débris or applying proper means for destroying their power to work harm.

A liberal supply of wholesome water is an essential condition for health and comfort. This has been recognized most fully in our own country. Even the smallest towns are erecting water-works, and the large cities are either extending their existing works or are engaged in investigating the best method of improving as well as increasing their supply of water.

When the planning and construction of works of this kind is instrusted to experienced and skillful engineers, as is generally the case in our large cities, and when the usefulness of the engineer is not impaired by the interference of politicians or of another class of men that may be called "amateur engineers," the works are substantially constructed, with a view to economical operation, and with due regard to the necessities of the future.

In the smaller cities or towns, the mode generally adopted is for one of the many water-works companies or syndicates to undertake the planning and construction of water-works under a contract, by which they guarantee a fixed height at a certain price per annum, and also to supply water to the inhabitants at a rate agreed upon. But as the engineer in charge of municipal work too often has no special knowledge of hydraulic engineering, it is but natural that in most cases the lowest bid will be accepted, and just as natural that the company of syndicate which obtains the franchise for the construction and operation of the works, should plan the works with a view mainly to cheapness in first cost, and without any regard either to the quality of the water to be furnished, or to the permanency of the works. That under such a system, a good many of the water-works of our smaller cities should be more or less failures is hardly to be wondered at.

There are a number of companies in this business, who have a reputation to uphold, who employ competent engineers to plan and to construct the works which they have contracted for; but unless the city authorities should possess greater wisdom and knowledge of hydraulic works than they ordinarily are gifted with, some speculating syndicate will underbid, as it safely may, the responsible firm or company, and by building poor works will inflict a lasting injury on the community.

Of new devices used in operating water-works I may call attention to the æration of water, by means of air introduced into the pipes under pressure, for the purpose of destroying the organic germs, which otherwise might affect the salubrity or taste of the water.

A new method of investigating the purity of potable water has also been introduced. It consists in observing the colonies of microbes, which are produced in gelatine that has previously been sterilized. This method was first used in Berlin, and probably leads to more correct conclusions in regard to the salubrity of the water than any chemical analysis.

As regards cleaning the water from solid matter carried in suspension, our country cannot claim to have reached the same high standard as that obtained in other countries.

American practice, in cases where the water is taken from turbid streams, generally provides only for removing so much of the matter held in suspension as will subside during a certain period of quiescence in settling basins.

Filtering, so largely used in England and on the Continent, is used here in but few instances. One reason why filtration is not more generally adopted probably lies in the fact that the quantity of water consumed per capita in this country is largely in excess of all legitimate requirements. Of late years the quantity per head has been reduced by various means adopted to prevent waste. If efforts in this direction are continued and are reasonably successful, measures for improving the quality of our potable waters will probably be more generally adopted.

The most important and extensive works for the supply of water which are being carried on at present, are those of New York, U. S., and Liverpool England.

The New York works are intended to provide an ultimate daily supply of 320 million gallons. The main features are a masonry dam, 178 feet above the bed of the stream, and 1,300 feet in length, forming a lake, which will contain 3,200 million gallons. As the masonry of this dam has to be sunk more than 100 feet to reach rock foundation, its total height will be nearly 300 feet, and its width at the bottom about 200 feet. The aqueduct, which is to carry the water to the Central Park reservoir, is thirty-one miles in length, and of an average diameter of 14 feet. It crosses the Harlem river by an inverted syphon 150 feet below tide level. The construction of the aqueduct is rapidly progressing.

Of similar character, and of hardly less magnitude, are the works for the supply of water to Liverpool.

The Vyrnwy dam, of cyclopean masonry, is to be 136 feet high in the center, 1,258 feet in length and 117 feet thick in its widest part. The impounded water will cover 1,118 acres. The aqueduct will be thirty-five miles in length.

The work of the engineer, next in importance if its effect on health, be made the criterion, consists in providing for the removal of all refuse matter which, if allowed to remain, would affect the health or comfort of the community.

The need of works of this kind has become so fully recognized of late years that their construction has grown into a special branch of engineering.

The removal and disposal of human excreta, and of the waste water from dwellings and factories, present greater difficulties than that of any other kind of refuse.

Both scientific attainments and experience are required in the engineer who undertakes to select that system of sewerage which is best adapted to local conditions and requirements.

The system of carriage by water evidently is the only way practicable, in a country where the water-closet is so generally used as in the United States.

Whether the sewerage proper should be taken into the conduits, which, in most cities, it is necessary to construct to carry off storm water, or whether the sewerage should be carried off separately; in other words whether a combined or separate system of sewerage should, for any particular city or town, be chosen, can-

*Annual address of President Flad, delivered at the Denver Convention American Society of Civil Engineers, July 2, 1886.

not be properly determined without thoroughly weighing the advantages and disadvantages of either system, as applied to the particular place requiring the improvement. To insist that one of these systems should be exclusively used in all cases is, in my opinion, a position which the competent engineer ought not to assume.

With the combined system, the only rational method for the final disposal of sewerage consists in its discharge into large bodies of water in motion, except, perhaps, where extensive tracts of sandy soil are available.

Instead of entering into a discussion of the different methods used for finally disposing of the sewage under the *separate systems*, I will state that in my judgment the filtration of sewage, by allowing it to flow over large areas of underdrained land, (as is practiced with perfect success in many towns in England, and which has also been successfully introduced at the city of Pullman, Ill.,) is the most certain and most generally applicable method.

The appliances for receiving the sewage and conducting it from the houses—or what may be designated as plumbing fixtures—have lately been receiving much more attention than formerly, and our people are slowly learning, some of them by dire experience, that in building dwellings they should look to perfect design and workmanship in the execution of the plumbing work, rather than to its cheapness, if they desire to secure healthy homes.

Speaking of the disposal of refuse matter, I will mention that the burning of street sweepings and offal, in ovens constructed for the purpose, is successfully and economically carried on at Leeds and other places in England, and express the hope that this example will soon be followed in our own country.

But the burning of street sweepings can be accomplished only when the street pavements are constructed of material which is not readily abraded by the effects of traffic.

The necessity of procuring pavements of this kind is fully recognized, and the streets of Paris, London, Berlin, Vienna, New York, Boston, Chicago, St. Louis, Baltimore, Cincinnati and Washington are now nearly all being paved with the same kinds of materials, and under almost identical specifications. Granite blocks, wooden blocks and monolithic asphaltum are almost exclusively used in the principal streets of these cities. The granite pavement is the most durable, and requires the least repairs; the monolithic asphaltum takes precedence from a sanitary point of view, and the pavement made of blocks of wood, as lately constructed, is preferred by some on account of its being the easiest on horses and least noisy. But it still remains for the engineer to devise a pavement, durable and smooth, for use on streets where the traffic is not heavy enough to require granite or where the cost of either of the two other pavements above mentioned is too great to justify their application.

Macadam pavements, when good stone can be obtained, will, under proper treatment, give a smooth surface, agreeable for travel, provided they are kept in first-class order by the immediate repair of any defect. But this is a condition which can hardly be realized in this country, on account of the high price of labor.

Street pavement of hard burnt brick are now being tried on a large scale in a number of towns in Illinois. At Bloomington such a pavement has been in use since 1876. Blocks composed of coal tar, pitch and sand called ceramite, have been used for street pavements at Buda-Pesth since 1881. Both these pavements are laid in a similar manner.

Street pavements composed of round cedar blocks has been largely introduced in Western cities of late years, but can hardly be considered to fill all the conditions required for a good pavement on account of the unequal wear of the sap and heart wood.

Among those things which affect the health and comfort of the inhabitants of cities using bituminous coal, is the smoke from factories and dwellings. Many appliances for smoke prevention have been devised, some of which are reasonably successful. Their application mitigates the evil, if it does not wholly remove it; but it is to be hoped that the experience gained at points where natural gas has been found and applied to heating purposes, and the late improvements in the manufacture of heating gas, will, before long, lead our people to abandon the primitive mode of heating with solid fuel now in vogue, and thus abate the smoke nuisance.

A new problem is pressing itself upon the attention of the Municipal Engineer, one that presents special difficulties, and will require his best endeavors to satisfactorily solve. This is the proper method of arranging and carrying the numerous wires required for the electrical appliances which are now used in our cities and towns. In the larger cities where space is limited and the purposes to which electricity is applied are various, necessitating the employment of all kinds of electrical currents, many of which act injuriously upon each other, the electrical difficulties to be overcome are great, and by many are considered to be of such magnitude as to forbid the use of routes or ways in common. In the larger cities the public demand that the wires shall be placed under ground and undoubtedly they must be so placed to a greater or less extent. The electrical difficulties need not be considered here. The engineering difficulties are in themselves of sufficient importance. The solution of the problem which most naturally suggests itself is the building of large subways in which all the wires may be placed as well as the water and other pipes, pneumatic tubes and other modern appliances; the subways to be of a size admitting men to enter at convenient points for placing and repairing the wires and pipes without interfering with the street traffic. The cost of such subways would be so great as to forbid their construction except to a limited extent. On the other hand, the use of small conduits or tubes into which the wires shall be drawn through numerous openings in the street surface, will necessitate almost constant interference with traffic and frequent disturbance of the pavement of the streets and side walks for enlargements and repairs and for making connection with buildings.

I am inclined to think that, what may be designated as the mixed system would be the most satisfactory, under which large subways would be used on streets where the number of electric conductors, and of pipe lines required for all purposes, was sufficient to warrant expenditure for such structures; while, for the other streets, a system of aerial carriage and distribution might be devised which would be free from the gravest objections to the present practice, and which would admit of gradual expansion, without interrupting traffic, until the proper time for the construction of a subway had arrived.

Before dismissing the subject of Municipal Engineering, I desire to say a few words in regard to the difficulties which are in the way of a proper management of the Engineer Department of our cities and on the means for removing them, not specially for the benefit of the profession, but of the community at large. The greatest obstacles to the proper conduct of public work in cities and villages arise from the fact that the engineer is frequently selected from political preferences, which often gives the position to an incompetent man; and another obstacle is that the term of office is generally by law limited to one or two years, and does not allow enough time to even a competent engineer to become thoroughly acquainted with his duties, and with the distinctive features and requirements of the locality, before he is liable to be displaced.

If the evils arising from such a state of affairs are to be avoided, appointments should be based on strict civil service principles. No person should be appointed on any other ground than that of competency and honesty: and he should hold his office during good behavior, and all subordinates, should be selected on the same principles.

Some of our larger cities, recognizing the evil effects of political appointments of officers in charge of public works, and of frequent changes, tried to remedy the evil by placing the general management in the hands of Boards of Commissioners, generally selected from among prominent business men in the community. Changes of this kind usually were made, when a reform wind was blowing, it being supposed that, although changes in the members of such boards might take place, the intelligence of such a class of men would be a guarantee against causeless changes of employes.

This system whilst it has been an improvement on the old one has the disadvantage that members of these boards are too often hardly more than "figure heads," whose duties might just as well be performed by the engineer entrusted with the planning and execution of the public works. To make a Board of Public Works thoroughly useful the majority of the members should be engineers, each of whom should take charge of a particular department as its chief. By this system the board would have the benefit of the special information of each member as regards his own department as well as of his general knowledge of engineering matters. St. Louis, Providence and Milwaukee have partially adopted this system, and it is to be hoped that other cities will follow their example.

In connection with this subject, I am pleased to record the fact that in some cities positions on public works are now made dependent upon the result of examinations, held under civil service rules.

Next in importance to municipal engineering, I consider the work of the engineer in connection with railroads.

During 1885 about 3,000 miles of railroad were constructed in the United States. This is less than for any one year since 1858; yet there seems to be some revival in railroad construction, as, from January 1st to June 1st, 1886, 1,100 miles of railroad have been constructed, against 600 miles constructed during the corresponding period of 1885.

The total mileage of railways in the United States may now be taken at about 129,500 miles. The rapid increase of railroad traffic, and the introduction of freight cars carrying as much as 60,000 pounds has directed the attention of railroad managers to the necessity for the improvement of brakes for freight trains.

In a paper read before our Society it has been stated that the number of freight cars in the United States provided with power brakes on June 1, 1885, probably did not exceed 4 per cent. of the total number. In June, 1885, the Master Car-Builders' Association instituted a series of experiments, with a view of determining the merits of different brakes proposed for freight service. Another set of experiments upon automatic brakes is to be made under the auspices of the same association at Burlington, Ia., on July 13, 1886, in which the best brakes now in use will be brought into competition. The result of such competitive tests will be of great value to railroad interests.

Of all appliances used for increasing the safety of railroad operation, one of the most effective and important is the block-signal system, almost universally used in England, and which is to be hoped, that it will, before long, find general application in our own country.

A great obstacle to improvement in railroad operation arises from the great variety prevailing in the construction of rolling stock, and in appurtenances, and it would contribute greatly to safety and economy if uniformity in this respect could be attained.

If all, or at least a considerable number of railroad companies, would combine to establish, at common expense, a station where experiments and tests as to the value of railroad plant, rolling stock, and appliances could be made on a large scale, and under the direction of scientific and practical men, it would save them the expense of individual efforts and secure much more trust-worthy results.

As an instance in which the railroad companies have perceived the benefits arising from uniformity, I may mention the change of gauge from 5 feet to the standard lately made on the southern roads. Between May 31st and June 3d of this year, the gauge on 11,500 miles of road was changed with perfect success, and with hardly any interruption of traffic.

A great advance in the construction of mountain roads has been made by Abt, whose system has been successfully applied on the Harz Railway.

Ship railways have heretofore been used for transporting small vessels only, and it was reserved for a member of this Society to conceive the idea of applying railroads to the transportation of ships and largest seagoing vessels long distances over land in a manner which is fully indorsed by a number of eminent engineers and naval constructors.

The construction of the Chignecto Ship Railroad from the Gulf of St. Lawrence to the Bay of Fundy, similar in its details to those proposed for Tehuantepec, is now under contract, and the project of a ship railroad across the peninsula of Florida is being discussed.

The system of elevated railways is remarkably successful in the city of New York, and is being extended to the suburban districts north of that city. There are also several lines in operation, or in progress of construction, in Brooklyn and Kansas City.

Cable tramways were first used in San Francisco in the year 1873; in New Zealand, 1880; Chicago, 1882 London, England, 1884; Melbourne, Philadelphia and Kansas City, in 1885; and during the present year in New York and St. Louis.

For short lines this system has many advantages, but for long lines the use of some other motor will probably be found more economical.

Electricity, for several years, has been in use for operating city and suburban tramways. There are different methods of carrying the electric current from the central station to the cars. In almost every case a separate conductor is used, either over ground, as at Berlin, Baltimore and Giant's Causeway, or in slotted conduits similar to those used on cable tramways, but of smaller dimensions, as at Cleveland and on the Blackpool line.

Electric tramways have been tested during the year or are now in progress of construction at Toronto, New Orleans, Minneapolis, Detroit, Montgomery, Ala., Denver, Col., Appleton, Wis.

Different from these systems is that of Reckenzaun, who carries the electricity for operating the motor along with the car in a storage battery. This system is now being tried at Battersea, England. If storage batteries can be constructed, which, besides being light and durable, will return a fair percentage of the amount of the power used in charging them, this system would give promise of great economy and convenience.

The rapid development of the application of electricity to many of the necessities and comforts of civilized life would seem to demand that more attention than heretofore should, by the profession at large, be paid to this branch of engineering. A knowledge of this science will, within a few years, be just as necessary to the civil engineer as is to-day the knowledge of hydraulics.

The building of inland canals has on this Continent nearly ceased, as railroad transportation, although more expensive, insures greater regularity and dis-

patch, and is not subject to stoppage during winter, as are our Northern canals. Canal work is now almost entirely confined to deepening and widening the existing lines. The Welland and the Erie canals are being thus treated. The locks of the Sault St. Marie canal have been deepened, so as to admit vessels of 16-feet draft.

But while the construction of inland canals is now at a standstill, a number of ship canals are in progress, or projected. The most important of these, the Panama canal, is, according to latest advices, not making such progress as to satisfy the friends of the enterprise. Indeed, it would appear that if completed at all, it will have to be changed into a canal with locks.

The canal across the Isthmus of Corinth is in progress.

Among projects for ship canals which are reasonably certain of being carried out in the near future, is the canal between the Baltic and the North Sea; and the Manchester canal in England. Canals are also proposed from the Baltic to the White Sea *via* Lake Onega and across the Isthmus of Nicaragua.

These engineering works, when completed, cannot fail to exercise a very beneficial influence on the commerce of the world.

The subject of irrigation is one of the utmost importance to some States and territories, and a large amount of this class of engineering work has been done in California, Arizona, Colorado, Dakota, Montana, Idaho, Oregon and Georgia. The total length of ditches, pipes and flumes is estimated at over 10,000 miles. The greatest progress in regulating the collection and distribution of water for purposes of irrigation has been made in Colorado, and the wise laws made by this State are considered and used as models by other States.

From the excellent report of the State Engineer of Colorado, it appears that there are over 26 water districts in existence in the State, distributing over 1,000,000 cubic feet of water per minute for the purpose of irrigation. The number of acres irrigated in this State exceeds 1,400,000. An irrigating canal, thirty miles in length, is now under construction at Catlin, Col.

The extent and cost of some irrigating works is shown by a description of the canal in the San Joaquin Valley, in Merced County, California. This canal is about half completed, and will, when finished, have a total length of 35 miles. It is to pass through two tunnels one 1,600 feet, the other 6,000 feet in length. The total cost of the work is expected to be $1,500,000.

A still larger irrigating canal is being excavated in northern Wyoming, and will be more than 100 miles in length.

The improvement of our rivers, and more particularly of the Mississippi river, in which one-third of the population of the United States is directly interested, has made but little progress during the past year, owing to the failure of Congress to make the necessary appropriations. A costly plant of steamboats, barges, pile-drivers, etc., had been prepared for the prosecution of the work. Not only does all this plant remain unused, but the works already begun which avowedly had been constructed rather light for the purpose they were intended to serve, are gradually giving way under the attacks of the river, and before long if not cared for will altogether disappear. This making appropriation sufficient to start work one year, and refusing next year even the money necessary to secure and complete the work already commenced, is certainly the height of folly, and it is to be hoped our Congress when arriving at a full understanding of the effects of such action, will not hesitate to change it. The completion of the Davis Island dam, on the Ohio river, during the year marks a very decided forward step in the improvement of that river.

The storage reservoirs which have been constructed on the Mississippi river, 300 to 500 miles above St. Paul, with a view toward regulating the flow of water in the river, were opened on the 1st of August, 1885, and have, so far as can be ascertained, fulfilled all reasonable expectations as to their effect, and it is probable that these results, achieved with a comparatively small outlay of money, will encourage the authorities to further steps in this direction.

In the field of military engineering, complete success has crowned Gruson's efforts to construct shields and cupolas of chilled cast-iron. Experiments have been prosecuted in torpedo construction and service, also on the firing of shells filled with nitro-glycerine, which are said to have been successful. In addition to the foregoing the Maxim machine gun, operated by the recoil, is a very important invention in gunnery.

It is greatly to be hoped that Congress will, before long, see the necessity of providing for our sea-coast defences. When this is done, the present number of engineers U. S. A. would hardly suffice to plan and construct these works, and they would then be fully employed in the sphere of military engineering proper leaving the improvement of rivers and harbors, and of all works of a civil character, to civil engineers. This would be the most natural and easy solution of the question now under discussion between members of the profession as to the proper policy of conducting public works. While it is my opinion that public works of a civil character could as well be carried on by civil engineers, appointed under strict application of civil service rules specially adapted to the purpose, I am opposed to any action by our Society which might seem to be directed against the interests, or even privileges, of a number of our members, who are second to none in scientific attainments, in experience and in character.

Tunneling, now-a-days, can be done much more expeditiously and cheaply than formerly, in consequence of the improvement in drills and in explosives, coupled with better methods of ventilation.

Of large tunnels recently opened to traffic may be named those of the Severn and the Mersey.

The construction of the Cascade Tunnel, on the line of the Northern Pacific Railway, has been commenced. It will be 9,850 feet in length, and next to the Hoosac the longest railroad tunnel in America.

Projects are on foot for several new Alpine tunnels; among them, for a tunnel under Mont Blanc, which is to be twelve miles in length, and under the Simplon, which is to be twelve and a half miles long. But a prediction has been made based on the experience gained on other Alpine tunnels, that the heat in the Central portion of the Simplon tunnel would prove so great as to make human life impossible.

A project for a tunnel under Northumberland Straits, between Cape Traverse and Tormantine, deserves to be mentioned, as it proposes some bold and novel features of construction, and yet seems to be so well considered in all its details as to give fair promise of success.

The project of a tunnel under the Straits of Dover, according to late information, has a fair prospect to be revived. It is very desirable that a work which will confer such great benefits on the two countries which it is to unite should be completed, particularly since the work already done has made it a certainty that the construction of the tunnel is not only practicable, but that it can be constructed in a shorter time and for less money than was originally estimated.

By far the largest work of subaqueous tunneling for the purpose of removing rock impeding navigation was that of Flood Rock in Hell Gate. The area over which the work extended comprised nine acres. By the final explosion of October 10, 1885, 225,000 pounds of rackarock, and 75,000 pounds of dynamite were used, a quantity of rock estimated at 200,000 cubic yards was shattered so as to admit of ready removal by dredging.

The greatest activity in any branch of civil engineering during the past year seems to have prevailed in bridge construction. Quite a number of important bridges have been completed, among them the bridges across the Susquehanna river, on the Baltimore & Ohio Railroad, 6,315 feet in length, and having four spans of 480 feet and one of 520 feet; the Henderson bridge, across the Ohio river, 3,200 feet in length, with one span of 525 feet; and the St. John's river cantilever, 447 feet between piers, and the bridge across the Big Black river. Of large bridges in course of construction, the most important is the Forth bridge, with two spans of 1,700 feet each, and the Sukkur bridge, across the Indus, having a span of 790 feet; and finally the Lachine bridge on the Canadian Pacific Railroad, with two spans of 408 feet.

The contract for the erection of a bridge at Hawkesbury, New South Wales, has lately been awarded to one of our American bridge companies—a very gratifying fact when it is considered that the contract was obtained in competition with the bridge companies of England and France. The main difficulty to be overcome in the construction of this bridge lies in its deep foundations, which are to be sunk to a depth of 170 feet below the surface of water.

The extremely low price of iron and steel greatly favors the selection of long spans for bridges, as the saving in piers and foundations balances the extra cost (per lin. foot) of long spans.

The tendency among bridge engineers, at present, seems to be favorable to the selection of systems in which the strains to which any member may be subjected can be accurately determined by calculation, and the use of the pin joint, which may be called a distinctive feature of American bridge construction, favors the attainment of this object.

The rapidity with which bridges with pin joints can be erected is an immense advantage, particularly when material for such bridges has to be prepared at a great distance from its final destination, or when erection must take place where no facilities for doing iron work exist. The system of construction is therefore particularly adapted for new and thinly settled countries.

Since the great success of the Cantilever Bridge at Niagara Falls, a number of other bridges have been built on this principle. Indeed, by far the greater number of long-span bridges lately proposed are to be cantilevers, as this system offers great advantages in erection. But they are subject to greater deflections than those built on other systems, and I believe that the arch might, in many cases, be preferable, as it gives almost the same facilities in erection and is less deflected under the action of a moving load. I am glad to see the arch proposed in a late design for the Harlem river bridge.

As I have before mentioned, both the weight of locomotives and of cars has greatly increased of late, and bridges constructed years ago of sufficient strength to carry the load which, at the time of their erection, was considered a possible maximum, are now, by the increase in the weight of rolling stock, subjected to loads which greatly reduce their factors of safety. There are undoubtedly a great many of the older bridges which require to be strengthened or replaced, if accidents are to be avoided.

I think it is the duty of the members of the profession to direct the attention of State governments to this fact, and to suggest that thorough examinations of all bridges be made. This would be a work of considerable magnitude, and would require both time and money; but in a civilized commonwealth the care for the safety of its citizens should outweight any financial considerations.

The necessity of tests and experiments when new forms or new materials are to be introduced, will be readily admitted. To make such tests, not on small models, as at one time was considered sufficient, but on full-sized members, as has been shown to be preferable, requires large testing machines and plenty of time and money. No individual engineer and but few corporations can afford to provide the necessary funds for this purpose. It was, therefore, proper that, for the advancement of science, as well as for the benefit of the material interests of the whole country, the United States Government should cause a testing-machine, of large dimensions, to be built, which, under proper regulations, would be accessible to engineers and manufacturers for tests of material.

Such a machine was built at Watertown, and has been in use for several years, and of very great service; yet, as it is under the immediate control of the Ordnance Department of the United States Army, it is, during a great portion of the time, necessarily employed in the service of that department, and as a great many of the specimens tested, are of small dimensions, so that the experiments made thereon are not of any value to the general public, the primary object for which the construction of this machine was undertaken is partly defeated.

A remedy could be found if the United States Government could be induced to erect, in addition to this large testing machine, some machines of smaller dimensions, and at the same time to appropriate an amount sufficient to pay for tests not of special but of general interest, and for the time of engineers specially charged with the work.

While on the subject of tests, I may mention that, during the past year, there have been made public the results of a number of valuable experiments made by members of this Society, on cements, on the comparative value of lubricants, on evaporation, and on the strength, elasticity, etc., of iron and steel, and on other matters of interest to the profession.

The use of the new system of notation of time is gradually extending, and promises to become universal in application. The introduction of the metric system is progressing not quite so rapidly as might have been expected from the progressive spirit of our nation. It seems strange that, in this age of rapid interchange of goods and thoughts between civilized nations, such an obstacle as the use of different measures in different parts of the globe should be allowed to exist. Nobody can doubt that this obstacle will be removed before long, and the only question can be what system should be adopted.

There are now 242 millions of people using the metric system, and the weight of numbers is probably already on the side of that system. This may be balanced, or even outweighed, by the industrial prominence of the nations which use the English standard; but the selection should clearly not be made, either on the basis of the greater number now using a particular system, nor on the cost of the change in money, or in temporary inconvenience; but it should be made on the intrinsic merits of the system. And there can be no doubt but what the metric system fulfils almost every condition of a perfect system of measurement, and could hardly be improved.

Among the strong objections to the introduction of the metric system has been the necessity which it involves of a partial remodeling of our tools in workshops. This would undoubtedly be very great; but the saving in time to all classes who are engaged in any kind of business requiring measurement and calculations (and there are but few which do not require them) would soon make up for this loss. As to the inconvenience resulting from its introduction in the ordinary walks of life, it will, judging from the experience of Germany, hardly be felt in a country in which education is so universally distributed, and the mental activity of the people so strongly developed as in our own. But even our manufacturers may be willing to agree to the change, when they consider that

many of the countries showing the most rapid progress, such as Brazil, Mexico and the Republics of South America have adopted the metric system, and that this gives to France and Germany a great advantage over the United States in selling to these countries their manufactures.

I am glad to be able to state that a bill has been introduced in Congress which prescribes that after the 4th day of March, 1889, the metric system shall be exclusively used in all transactions in which the Federal Government is concerned.

I may congratulate you upon the rapid growth of the Society, both in numbers and in influence, but it is yet far behind the Institution of Civil Engineers of England as to numbers, and probably even more so as regards influence; this is mainly due to the fact that English capital has been largely employed in the English colonies and in foreign countries in enterprises managed by English engineers; while our capital and the services of our own engineers were, until lately, almost exclusively needed at home; and to the further fact that the English people hold the profession, which produced some of their greatest men, such as Watt, Smeaton and Stephenson, in higher esteem than has been the wont of our own fellow-countrymen.

But our country is getting both richer and wiser every day, and I hope the time is near at hand when our engineers will attain a wider sphere of action, and a higher degree of public esteem. Those of us who have seen engineering, as a profession, start into life in the United States, may not see that hope realized, but we have the satisfaction of knowing that we have earnestly striven for the attainment of this end.

List of engineers, members and guests, with ladies, attending the Denver Convention:

President: Col. Henry Flad, President Board of Public Works, St. Louis, Mo.; *Vice President*: Thomas C. Keefer, Mrs. and Miss Keefer, Ottawa, Canada; *Secretary*: John Bogart and Mrs. Bogart, New York City; *Treasurer*: J. James R. Croes, and Miss Croes, New York City; *Directors*: George S. Greene, Jr., Engineer in chief, Dept. of Docks, and William R. Hutton, Consulting Engineer, Mrs. Hutton and Miss Hutton, New York City, and the following:

E. C. Appleton, Resident Engineer, B. & M. R. R., Ashland, Wis.; J. F. Barnard, General Manager H. & St. J. and K. C. St. J. & C. B. railroads, Mrs. Barnard, Miss Barnard, St. Joseph, Mo.; Edward Baumann, Mrs. Baumann Miss E. Baumann, and Edgar Baumann, Chicago, Ill.; Thomas S. Bishop, Engineer Russell & Erwin M'f'g. Co., New Britain, Conn.; Charles Blackwell, Union Pacific Ry., Mrs. Blackwell, Omaha, Neb.; J. Blickensderfer, Chief Engineer, U. P. Ry., Omaha, Neb.; Henry I. Bliss and Mrs. Bliss, La Crosse, Wis.; A. Bonzano, Vice-President and Chief Engineer, Phœnix Bridge Co., Mrs. Bonzano, Phœnixville, Pa.; Wm. F. Booth, Poughkeepsie, N. Y.; Andrew Bryson, Principal Assistant Engineer, Kings Co. "L" Ry., Brooklyn, N. Y.; George Burnet, Jr., of the firm of Taylor, Burnet & Co., Engineers and Contractors, St. Louis, Mo.; Clifford Buxton, Chief Engineer, T. & O. C. Ry., Mrs. Buxton, Miss Eva Buxton, Mrs. W. H. Vandergrift, Toledo, O.; W. W. Card, Secretary Westinghouse Air Brake Co., Pittsburg, Pa.; O. Chanute, Consulting Engineer, Kansas City, Mo.; Eliot C. Clarke, Boston, Mass.; Wm. B. Cogswell, General Manager, Solvay Process Co., Miss Mabel Cogswell, Syracuse, N. Y.; Mendes Cohen, Mrs. Cohen and Miss Cohen, Baltimore, Md.; F. Collingwood, Consulting Engineer, Elizabeth, N. J.; B. L. Crosby, Resident Engineer, Rulo Bridge, Rulo, Neb.; D. W. Cunningham, Grandin, Dakota; Joseph P. Davis, Consulting Engineer, New York City; Frederick De Funiak, President New Orleans Elevated R. R. Co., Mrs. De Funiak and Mrs. Sterling B. Toney, Louisville, Ky.; S. B. Downes, New York City; Geo. D. Emerson, Professor of Engineering, School of Mines, Rolla, Mo.; C. A. Ferry, Asst. City Engineer, Mrs. Ferry, New Haven, Conn.; Robert Fletcher, Professor of Civil Engineering, Dartmouth College, Hanover, N. H.; S. Waters Fox, St. Joseph, Mo.; H. H. Filley, Chief Engineer Mexican National Ry., City of Mexico, Mex.; Carl Gayler, Bridge Engineer, St. Louis, Mo.; Chas. E. Goad, Montreal, Canada; Bryant Godwin, New York City; Chas. E. Greene, Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich.; Edward B. Guthrie, Assistant in charge of Sewers, Buffalo, N. Y.; Wm. G. Hamilton, Ramapo, N. Y.; Wm. J. Haskins, New York City; Rudolph Hering, Chief Engineer, Drainage and Water Supply Commission, Mrs. Hering and Master Oswald Hering, Chicago, Ill.; H. V. Hinckley, Office Engineer, A. T. & S. F. R. R., Mrs. Hinckley, Topeka Kan., and Miss Bessie O. Hinckley, Mobile, Ala.; M. L. Holman, Principal Assistant Engineer, St. Louis Water Works, St. Louis, Mo.; F. B. Howard, Detroit, Mich.; William R. Hutton, Consulting Engineer, Mrs. Hutton, Miss Hutton, New York City; John B. Johnson, Professor Civil Engineering, Washington University, St. Louis, Mo.; H. F. Juengst, St. Joseph Water Co., St. Joseph, Mo.; Geo. A. Kimball, City Engineer, Somerville, Mass.; Geo. W. Kittredge, Engineer, Maintenance of Way, J. M. & I. R. R., Mrs. Kittredge, Columbus, O.; Charles Latimer, Engineer N. Y. P. & O. R. R., Cleveland, O.; William H. Lotz, Mechanical Engineer, Mrs. Lotz and Miss Bertha Lotz, Chicago, Ill.; M. W. Mansfield, Supt. I. & V. R. R., Mrs. Mansfield, Indianapolis, Ind.; Robert E. McMath, Sewer Commissioner, St. Louis, Mo.; John J. McVean, Chief Engineer, D. L. & N. R. R., Ionia, Mich.; Thomas C. Meyer, New York City; D. E. McComb, Assistant Engineer, District Government, Washington, D. C.; Robert Moore, St. Louis, Mo.; Geo. S. Morison, New York City; Geo. B. Nicholson, Chief Engineer, C. N. O. & T. P. Ry., Cincinnati, O.; John Nichol, Engineer and Contractor, Mrs. Nichol, Chicago, Ill.; Albert F. Noyes, City Engineer, West Newton, Mass.; Fred S. Odell, New York City; John F. O'Rourke, Engineer in charge, Wisconsin River Bridge, Prairie du Chien, Wis.; Franklin C. Prindle, Civil Engineer, U. S. N., Mrs. Prindle, East Orange, N. J., and Mrs. Barney, Geo. S. Rice, Miss Helen Nelson and Mrs. Henry A. Mears, Georgetown, Col.; Joseph R. Richards and Mrs. Richards, Boston, Mass.; William Roberts and Mrs. Roberts, Waltham, Mass.; Andrew Rosewater, City Engineer, Omaha, Neb.; L. W. Rundlett, City Engineer, St. Paul, Minn.; T. F. Richardson, Division Engineer, C. B. & N. R. R., and Mrs. Richardson, Prairie du Chien, Wis.; Geo. F. Swain, Professor Massachusetts Institute Technology, Boston, Mass.; Stevenson Towle, Consulting Engineer, Miss Alice and Miss Jennie Towle, New York City; Alfred W. Trotter, Assistant General Manager, S. A. & O. R. R., Bristol, Tenn.; Mrs. John T. Trotter, New York City; John G. Van Horne, Mrs. Van Horne and Miss Ida Van Horne, Jersey City, N. J.; F. W. Watkins, Engineer Division No. 6, New Aqueduct, Morris Dock, Miss Watkins, New York City; C. D. Ward, Mrs. Ward, Jersey City, N. Y.; J. A. L. Waddell, Council Bluffs, Iowa; J. W. Walker, Proprietor The Shiffler Bridge Works, Pittsburg, Pa. John F. Wallace, Construction Engineer Central Iowa railroad, Mrs. Wallace, Keithsburg, Ill.; James R. Wardlaw, Assistant Engineer Department Public Works, New York City; Professor Wm. Watson, Secretary American Academy of Arts and Sciences, Boston, Mass.; Fred C. Weir, President, The Weir Frog Co.; Cincinnati, O.; A. M. Wellington, Editor *Railroad Gazette*, Mrs. Wellington, New York City; Thomas J. Whitman, Water Commissioner, St. Louis, Mo.; William H. Wiley, representing ENGINEERING NEWS and *Engineering*, Mrs. Wiley, Miss Wiley, New York City; and Mrs. Henry G. Morris, Philadelphia, Pa.; C. M. Woodward, Professor of Mathematics and Mechanics, Washington University, Mrs. Woodward, St. Louis, Mo.; S. H. Yonge, U. S. Assistant Engineer Kansas City, Mo.; Clark Fisher, Trenton, N. J.; B. H. Greene, Surveyor General of Montana, Mrs. Greene, Helena, Montana; J. D. Hawks, Chief Engineer, Michigan Central Ry.; Mrs. Hawks, Detroit, Mich.; Arthur Howland, Boston, Mass.; E. C. Kinney, Assistant Chief Engineer, U. P. Ry. Omaha, Neb.; Charles Macdonald, Union Bridge Co., Mrs. Macdonald, New York City; James R. Maxwell, Division Engineer, N. P. Ry., Newark, Del.; W. S. Lincoln, Chief Engineer, W. St. L. & P. Ry., Mrs. Lincoln, St. Louis, Mo.; H. G. Morse, Morse Bridge, Co., Youngstown, O.; E. W. Eckert, Massillon Bridge Co., Massillon, O.; David Reeves, President Phœnix Iron Co., Mrs. Reeves, Philadelphia, Pa.; Robert B. Stanton, Civil and Mining Engineer, Mrs. Stanton, Denver, Col.;

Guests and Visitors as follows:

Geo. G. Anderson, Chief Engineer, N. C. Irrigation Co., Denver, Col.; M. E. Bergino, Mechanical Engineer, Denver, Col.; Henry Blattner and Mrs. Blattner, St. Louis, Mo.; E. M. Boggs, Assistant Engineer C. H. V. & T. R. R., Columbus, O.; Hubert A. Bonzano, Phœnixville, Pa.; C. N. Boggs, Assistant Professor Civil Engineering, Ohio State University, Columbus, O.; Oney Caistarphen, Surveyor General's office, Mrs. Caistarphen, Denver, Col.; Edmund S. Davis, Secretary and Treasurer, Denver Soc. C. E., Denver, Col.; James A. Dawson, Surveyor General, Mrs. Dawson and Miss Dawson, Denver, Col.; A. I. Fonda, Denver, Col.; Chas. A. Hinckeldeyn, Technical Attaché of the German Legation at Washington, New York City; William A. Jefferies, Am. Soc. C. E., New York City; T. A. Jobs, Denver, Col.; Edmund Kirby, Assayer, Denver, Col.; Frank Lawlor, Division Engineer, Iowa Division, C. B. & Q. R. R., Burlington, Iowa; Thos. B. Lee, Am. Soc. C. E., and Mrs. Lee, New York City; Frank A. Maxwell, U. S. Deputy Mineral Surveyor, Mrs. Maxwell, Georgetown, Col.; John W. Meier, Heine Safety Boiler Co., St. Louis, Mo.; J. A. McMurtrie, Denver, Col.; H. B. Patten, Division Engineer, Wyoming Division U. P. Ry., Laramie, Wyoming; W. A. Peck and Mrs. Peck, Denver, Col.; E. L. Rogers, Denver, Col.; Charles A. Russell, U. S. Deputy Mineral Surveyor, Boulder, Col.; R. W. Ryan, New York City; Pemberton Smith, Buffalo, N. Y.; W. A. Somers, St. Paul, Minn.; Henry A. Swenson, Engineer St. P. & D. R. R., St. Paul, Minn.; H. P. Taussig, Engineer Terminal Facilities, St. Louis, Mo.; John S. Titcomb, Cheyenne, Wyoming; Dr. A. B. Van Horne, Granger, Col.; P. H. Van Diest, Denver, Col.; Yoshichika Wada, Japanese Legation, Washington, D. C.; and Montgomery Waddell, New York City.

The United States Navy Question.

The people of the United States are better fitted to build a modern navy than any other people in the world. They are inventive, constructive, executive, persevering, enterprising and rich. The same circumstances which have produced Morse, Dahlgren, Ericcson and Edison; the same characteristics which have placed them ahead of all other nations in applying science to practical affairs and in pushing through great enterprises, would enable them to build a navy of a higher type than any the world has yet seen.

A navy at the present day is an organization comprising floating fighting machines of various kinds, and a number of men capable of handling them; and it is clear that ships, guns and torpedoes, together with the apparatus by which they are controlled, are in reality machines or tools adapted to special work, but constructed and operated on the same principles as govern all machines, tools, engines and structures.

So, the modern naval profession has become a branch of the broad science of engineering, advancing as that science advances, and contributing in turn to the progress of engineering by each invention made and principle discovered in naval science; for, since the principles of mechanics, mathematics, physics and chemistry underlie all branches of engineering, a step in one branch affects all the other branches.

The happy result attending the close relationship which has thus sprung up between naval science and engineering, is clearly to place the navy more within the sympathies of the people; since engineering, including civil engineering, steam engineering, sanitary engineering mining engineering, electric engineering, metallurgy, chemistry, etc., is very closely identified with the interests of the people, even in time of peace.

Now, the idea that the interests of the navy can be in accord with the interests of the people, in time of peace, is not generally held; and a prominent paper went so far, a few days since, as to say that the interests of the navy were opposed to the interests of the people. While, too, the maintenance of a small but efficient navy is approved by most men, it is nevertheless considered a disagreeable necessity, and one entailing an enormous expense, allowable only because it may save a greater expense in time of war; and as most people have read Marryat, the naval man appears to their imagination as a man apart from other men, full of strange sea-slang, horribly profane, chewing tobacco, bow-legged and usually drunk.

A very brief consideration will show, it is believed, that the interests of the navy are closely allied to the interests of the people, instead of opposed to them; so that the building of a suitable navy would not benefit the navy alone, but the people also.

The work of the navy in aiding navigation along the coast and on the high seas, and in publishing books and charts for mariners, need not be mentioned, for this is well understood; but the good which would be done in the interior of the country by constructing a suitable navy is not generally understood.

Perhaps the most direct good done would be the stimulation of the iron industry, and the unquestioned improvement which would follow in the manufacture of steel. The construction of a number of ships sufficient to act as an insurance on our property near the coasts, would benefit, not only the men engaged in the actual building of the ships, but also the men engaged in the mines, in the transportation of the ore from the mines, in the reduction of the ore in blast furnaces, in the making of steel, in the forging of large masses of steel, and in the fabrication of these masses into engines, armour, plates, guns, gun-carriages, etc.

And the ordering of large forgings of the finest steel by the navy department would justify capitalists in making the most elaborate and costly experiments looking to improvements in the quality of steel, to a cheapening of the methods of its production, and to a solution of certain problems as to the nature of steel, which would enable them to turn out steel of any desired combination of physical characteristics, such as tensile strength, elastic strength, elongation, etc., with unfailing precision. The necessary hammers and presses also which capitalists would erect, to furnish the navy with large forgings, would enable them to produce large masses of steel for other purposes, such as the building

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* By Lieutenant Bradley A. Fiske, United States Navy. From *Van Nostrand's Magazine*.

of machinery and of large structures throughout the country.

But we must not suppose that it would be only by the direct means of the employment of hundreds of thousands of men and the improvement in steel making that the prosperity of the navy would increase theprosperity of the country, for we must not forget that, by reason of the close relation now borne by naval science to engineering and to the scientific work of the country,any improvement in ships, guns, engines,and apparatus is at once felt all over the land.

Take the science of steam engineering for example. No one can hold that improvements, inventions, and discoveries in this science do not benefit the whole country, for steam engines are used everywhere, their use is daily increasing,and the principles underlying the construction and operation of all steam engines and boilers are the same, no matter to what special purpose any special kind of engine or boiler may be applied. Now, many of the most important improvements in engines and boilers have been brought about by the requirements of war ships, but the fact of an improved type of engine or boiler having been first usedin a war ship has not prevented that improved type of engineor boiler from being used in merchant ships afterwards. A few years ago a steam pressure of thirty pounds per square inch was thought enormous, but now there are torpedo boats abroad which are run with 150 pounds pressure, with proportionate increase of horse power per pound of coal; and multitubular boilers have been made to work at a pressure of 500 pounds, expending only a little more than a pound of coal per horse power per hour. It seems a very short time ago also that compound engines were first tried, in which the steam after doing its work in one cylinder in forcing the piston to one end of its stroke, was exhausted into another cylinder, and did similar work there at a lower pressure—and now we hear of engines in which the steam is made to expand in four cylinders in succession before it is allowed to exhaust into the condenser.

In every country, let it be borne in mind, in which great progress has been made in steam engineering, a very large part of the incentive has been the inducement held out by the Government to builders of the best engines for war ships; and the reason that the United States has dropped so far behind England and France in engine-building is simply that the Royal navy and the French navy have advanced, and the United States navy has not.

The struggling science of electric lighting also has been aided largely by naval patronage, for in Europe, and to some extent in this country,electric companies have received much substantial encouragement in the shape of orders for lighting war ships; and the tests of dynamos and incandescent lamps upon which the most reliance is placed all over the world are those undertaken for the Franklin Institute by a committee which consisted for the most part of navy and army officers, whose chairman was a young officer in our navy.

Certainly it will not take much consideration to show us that in the matter of ship construction too, the interests of the navy and the people are identical, for we can see at once that the plant needed for building steel warships and the experience gained in building them would enable shipbuilders to improve and to cheapen the construction of steel merchant-ships, and even of boats. A comparatively small reduction in the price of steel plates would permit the construction of steel ships and boats at about the present price of wooden ships and boats. Steel schooners, for instance, could be built instead of wooden ones, and besides being more durable and strong, they would cost less for repairs.

Even in the line of explosives we can see that the requirements of modern warfare have contributed to the march of civilization and to the comfort and happiness of mankind, for the most reliable experiments made with explosives have been made with a view to developing weapons of destruction, and yet the conclusions reached and the improvements made have put means in the grasp of the engineer, the miner, and the pioneer for blasting through solid rock with speed and safety.

That a close sympathy exists between the naval,professional and other branches of engineering is shown by the very numerous applications to warfare that are made of new discoveries, and by the fact that the sciences of steam engineering, shipbuilding, ordnance, etc., keep pace with the rapid advance of kindred sciences. New developments are constantly appearing. In steam engineering the rapid increase in the pressure at which steam is carried, in the quantity of coal burned per square foot of grate surface, rendered possible by the increasing use of the forced draft, coupled with great decrease in the weight of engines and boilers—all show that we are approaching speeds in ocean steamers that were undreamed of a few years ago. The progress going on in ordnance is more rapid still; ranges are increasing fast, and projectiles are growing rapidly in weight, and as yet we can see no limit either to range or to weight of projectile. The science of ordnance is evidently in its infancy, especially in the matters of projecting large masses of high explosives through the air, and in swiftly and accurately propelling auto-mobile torpedoes under water. The application of electricity to ordnance is just beginning to throw its shadow before; for though we see it now used for firing guns and torpedoes, and for steering and propelling torpedoes at a distance, it is evident that it will soon have a larger field and be used for pointing great guns with speed and precision, and for communicating between vessels at sea without wires. The machine gun already fires 1,000 bullets per minute; the revolving cannon fires with good aim twenty shells per minute, each shell weighing about four pounds; and the light rapid-fire gun fires fifteen shells per minute with good aim, each shell weighing six pounds and capable of piercing 4 inches of iron. All of these guns operate by hand, and are nearly automatic; but the Maxim gun introduced into England is absolutely automatic, the recoil of one shot furnishing the energy for loading and firing the next, etc. The problem of swiftly turning steamers is being rapidly worked out, some torpedo boats abroad being now able to turn within their own length. And we have just heard of a new explosive that promises to surpass nitroglycerine.

But this rapid improvement in all branches of naval science cannot continue without continued study and experiment. Now that Congress has decided that we ought to have an efficient navy, let us hope that Congress and the country will not suppose that progress has come to a standstill, and that we must stick fast to what has thus far been done abroad: for progress is marching with rapid steps, and the natural inventiveness of Americans will give us a great superiority over all other nations if we only profit by it.

The reverse plan has, however, been followed in this country for the past twenty years, and many American inventors, after having been discouraged or ignored by their own Government, have gone to Europe and received substantial encouragement, so that many of the best systems in use to-day by foreign powers are the invention of American citizens. Clearly "these things ought not so to be."

If we are content to follow where our natural genius shows that we should lead, we may attain certain results at a less cost of money than if we undertook experiments ourselves; but we shall always keep about two years behind other powers, so that in case of war we shall find ourselves at a proportionate disadvantage, and, besides, we shall never rise toso high an excellence as we should by properly encouraging American inventors to turn their thoughts to means for protecting their own country. Moreover, the inducements held out by the Government to inventors would operate not only to give the navy improved apparatus and machinery, but would also stimulate study of practical science all over the country and tend to enhance our material prosperity.

In case, however, we do not attempt progress, but stick fast to what has been done in England, refusing to spend money in experiments and fearing to make mistakes, so that our ships, guns, and engines will be virtually English, and in case one of these ships meets an English ship and whips her, let us not forget to give due credit—to England.

In view of the considerations urged above, showing that a dollar spent in the navy is not a dollar wasted, provided it be spent within the United States,let us hope that Congress in building an "efficient navy" will build a large navy. It is common to hear the opinion advanced that we need a good navy,but not a large one; that it would be opposed to our interests and contrary to our policy as a republic to have a large navy; and we hear it argued that what we need is a few good ships which could in time of war serve as a nucleus around which as large a navy could be constructed as the war might demand. This reasoning is fallacious; it would not have been fallacious twenty years ago, but it is fallacious now. Precisely the same causes as render it wise for us to have a good navy render it wise for us to have a large navy.

The reasons why we need a good navy are that our coast exposes a great many billions of dollars worth of property to anybody who choses to destroy it; and that the great speed of modern ships, the great thickness of their armor, and the great range of their guns, together with the existence of cables under all the seas, enable any European country (and some South American countries) to concentrate a large fleet on our coasts and bombard our towns in three weeks after declaration of war. How could a small but good navy serve as a nucleus at such a time? Under the very best circumstances, could this nucleus be developed into a sufficient navy in three weeks?

It would require two years at least. And after the new navy had been built, comprising large ironclads with suitable engines, guns, etc., whom would we get to manage them? Where would we get men capable of properly handling and fighting these monstrous machines full of elaborate engines, of guns of a great many types, controlled by complicated apparatus, of torpedoes, of gun-cotton, and other high explosives, etc.? We could not find them in the navy, because, granting that all the men in the navy had not long since been killed, we only had enough men originally in the navy for the nucleus; and the drafting of several thousand men at hazard, and the putting of them on board modern ships to manage their electrical apparatus and gun-cotton, might perhaps be a very interesting experiment, but it can hardly be prophesied in advance that it would be a successful one.

It must be plain that the expression "a small but efficient navy" is meaningless, because a navy cannot for our purpose be efficient if it is small. A navy to be efficient must fulfill the purpose for which it was intended, and as the principal purpose for which our navy is intended is to protect our coast against a sudden attack by a large modern fleet, it cannot be efficient unless it can repel that attack; and to do this it must comprise a great number of armored ships, equipped with the best and latest apparatus and manned with officers and men capable of handling that apparatus.

WATER

SHREVEPORT, LA.—The contract for the water-works and sewerage of Shreveport, La., advertised recently in ENGINEERING NEWS has been awarded to Samuel R. Bullock & Co., of New York City. Work will be commenced at once.

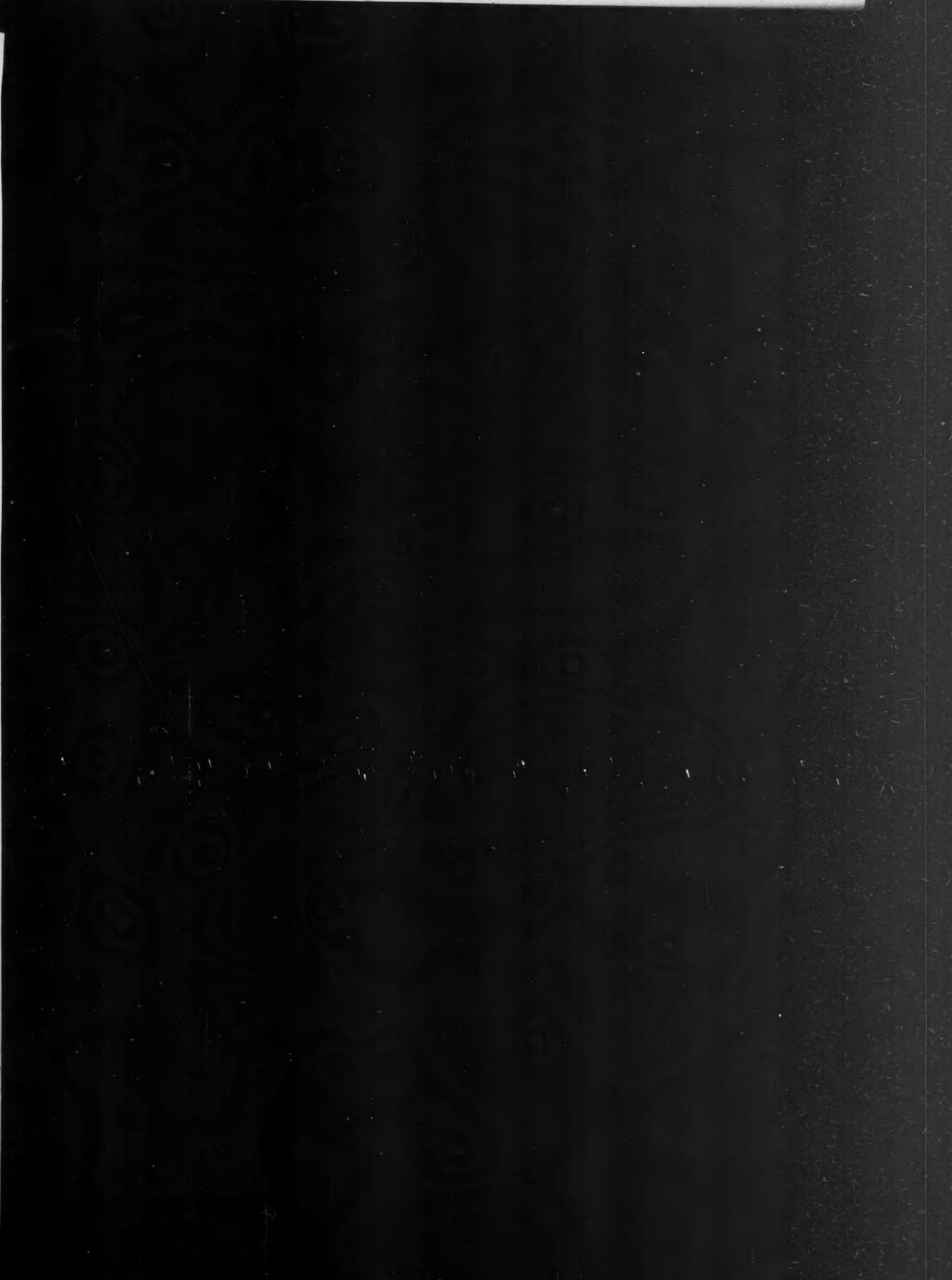
WELL SAID.—The New Bedford *Mercury*, reporting the proceedings of the Water-Works Association in that city, says: "After some further discussion, driven wells were taken up." That must be an association of experts.—Lowell *Courier*.

LITTLE ROCK, ARK.—Col. Zeb. Ward is building new water-works, the rapid growth of the city requiring works of greater capacity than those now in use. The pumps will be of the compound duplex type, built by the Geo. F. Blake Co. The reservoir is situated two miles from the city, and has a holding capacity of 20,000,000 gallons. This is said to be the only instance where a city the size of Little Rock is supplied with water-works built, owned and managed by a single individual.

THE Connecticut river, and the streams that make it, furnish power to 2,298 mills. These take 118,026 horse-power. The greatest number on any one stream are on Miller's River and its tributaries, 188, with 7,572 horse-power; the second is Chicopee river and its tributaries, 182 mills, with 14,901 horse-power; and the Farmington is third with 178 mills and 8,852 horse-power. The greatest power, however, is taken from the Connecticut itself, whose main stream supplies 98 mills with 23,366 horse-power.

CONSTANTINOPLE, TURKEY.—The Imperial Ottoman Ice Co. (Limited) has been formed for supplying Constantinople with ice. Capital $500,000. Franchise, a monopoly of twenty-five years to build factories and manufacture ice. Ice heretofore has come from Norway and was almost prohibitive in price. The population of Constantinople is estimated at 1,300,000 with about 3,000 cafés, 2,000 water sellers and nearly 1,000 ice cream makers, so that a good demand for ice is anticipated. The promoters get $450,000, leaving $50,000 as working capital. It is an English company, and Mr J. Spencer Balfour, M. P., one of the directors, estimates the profits at over $100,000 per annum.

CLINTON, MO.—The water-works are being built by P. B. Perkins. The capacity is to be 1,500,000 gallons per day. The supply of water will be drawn from Grand



of machinery and of large structures throughout the country.

But we must not suppose that it would be only by the direct means of the employment of hundreds of thousands of men and the improvement in steel making that the prosperity of the navy would increase the prosperity of the country, for we must not forget that, by reason of the close relation now borne by naval science to engineering and to the scientific work of the country, any improvement in ships, guns, engines, and apparatus is at once felt all over the land.

Take the science of steam engineering for example. No one can hold that improvements, inventions, and discoveries in this science do not benefit the whole country, for steam engines are used everywhere, their use is daily increasing, and the principles underlying the construction and operation of all steam engines and boilers are the same, no matter to what special purpose any special kind of engine or boiler may be applied. Now, many of the most important improvements in engines and boilers have been brought about by the requirements of war ships, but the fact of an improved type of engine or boiler having been first usedin a war ship has not prevented that improved type of engineor boiler from being used in merchant ships afterwards. A few years ago a steam pressure of thirty pounds per square inch was thought enormous, but now there are torpedo boats abroad which are run with 150 pounds pressure, with proportionate increase of horse power per pound of coal; and multitubular boilers have been made to work at a pressure of 500 pounds, expending only a little more than a pound of coal per horse power per hour. It seems a very short time ago also that compound engines were first tried, in which the steam after doing its work in one cylinder in forcing the piston to one end of its stroke, was exhausted into another cylinder, and did similar work there at a lower pressure—and now we hear of engines in which the steam is made to expand in four cylinders in succession before it is allowed to exhaust into the condenser.

In every country, let it be borne in mind, in which great progress has been made in steam engineering, a very large part of the incentive has been the inducement held out by the Government to builders of the best engines for war ships; and the reason that the United States has dropped so far behind England and France in engine-building is simply that the Royal navy and the French navy have advanced, and the United States navy has not.

The struggling science of electric lighting also has been aided largely by naval patronage, for in Europe, and to some extent in this country, electric companies have received much substantial encouragement in the shape of orders for lighting war ships; and the tests of dynamos and incandescent lamps upon which the most reliance is placed all over the world are those undertaken for the Franklin Institute by a committee which consisted for the most part of navy and army officers, whose chairman was a young officer in our navy.

Certainly it will not take much consideration to show us that in the matter of ship construction too, the interests of the navy and the people are identical, for we can see at once that the plant needed for building steel warships and the experience gained in building them would enable shipbuilders to improve and to cheapen the construction of steel merchant-ships, and even of boats. A comparatively small reduction in the price of steel plates would permit the construction of steel ships and boats at about the present price of wooden ships and boats. Steel schooners, for instance, could be built instead of wooden ones, and besides being more durable and strong, they would cost less for repairs.

Even in the line of explosives we can see that the requirements of modern warfare have contributed to the march of civilization and to the comfort and happiness of mankind, for the most reliable experiments made with explosives have been made with a view to developing weapons of destruction, and yet the conclusions reached and the improvements made have put means in the grasp of the engineer, the miner, and the pioneer for blasting through solid rock with speed and safety.

That a close sympathy exists between the naval, professional and other branches of engineering is shown by the very numerous applications to warfare that are made of new discoveries, and by the fact that the sciences of steam engineering, shipbuilding, ordnance, etc., keep pace with the rapid advance of kindred sciences. New developments are constantly appearing. In steam engineering the rapid increase in the pressure at which steam is carried, in the quantity of coal burned per square foot of grate surface, rendered possible by the increasing use of the forced draft, coupled with great decrease in the weight of engines and boilers—all show that we are approaching speeds in ocean steamers that were undreamed of a few years ago. The progress going on in ordnance is more rapid still; ranges are increasing fast, and projectiles are growing rapidly in weight, and as yet we can see no limit either to range or to weight of projectile. The science of ordnance is evidently in its infancy, especially in the matters of projecting large masses of high explosives through the air, and in swiftly and accurately propelling auto-mobile torpedoes under water. The application of electricity to ordnance is just beginning to throw its shadow before; for though we see it now used for firing guns and torpedoes, and for steering and propelling torpedoes at a distance, it is evident that it will soon have a larger field and be used for pointing great guns with speed and precision, and for communicating between vessels at sea without wires. The machine gun already fires 1,000 bullets per minute; the revolving cannon fires with good aim twenty shells per minute, each shell weighing about four pounds; and the light rapid-fire gun fires fifteen shells per minute with good aim, each shell weighing six pounds and capable of piercing 4 inches of iron. All of these guns operate by hand, and are nearly automatic; but the Maxim gun introduced into England is absolutely automatic, the recoil of one shot furnishing the energy for loading and firing the next, etc. The problem of swiftly turning steamers is being rapidly worked out, some torpedo boats abroad being now able to turn within their own length. And we have just heard of a new explosive that promises to surpass nitroglycerine.

But this rapid improvement in all branches of naval science cannot continue without continued study and experiment. Now that Congress has decided that we ought to have an efficient navy, let us hope that Congress and the country will not suppose that progress has come to a standstill, and that we must stick fast to what has thus far been done abroad: for progress is marching with rapid steps, and the natural inventiveness of Americans will give us a great superiority over all other nations if we only profit by it.

The reverse plan has, however, been followed in this country for the past twenty years, and many American inventors, after having been discouraged or ignored by their own Government, have gone to Europe and received substantial encouragement, so that many of the best systems in use to-day by foreign powers are the invention of American citizens. Clearly "these things ought not so to be."

If we are content to follow where our natural genius shows that we should lead, we may attain certain results at a less cost of money than if we undertook experiments ourselves; but we shall always keep about two years behind other powers, so that in case of war we shall find ourselves at a proportionate disadvantage, and, besides, we shall never rise to so high an excellence as we should by properly encouraging American inventors to turn their thoughts to means for protecting their own country. Moreover, the inducements held out by the Government to inventors would operate not only to give the navy improved apparatus and machinery, but would also stimulate study of practical science all over the country and tend to enhance our material prosperity.

In case, however, we do not attempt progress, but stick fast to what has been done in England, refusing to spend money in experiments and fearing to make mistakes, so that our ships, guns, and engines will be virtually English, and in case one of these ships meets an English ship and whips her, let us not forget to give due credit—to England.

In view of the considerations urged above, showing that a dollar spent in the navy is not a dollar wasted, provided it be spent within the United States, let us hope that Congress in building an "efficient navy" will build a large navy. It is common to hear the opinion advanced that we need a good navy, but not a large one; that it would be opposed to our interests and contrary to our policy as a republic to have a large navy; and we hear it argued that what we need is a few good ships which could in time of war serve as a nucleus around which as large a navy could be constructed as the war might demand. This reasoning is fallacious; it would not have been fallacious twenty years ago, but it is fallacious now. Precisely the same causes as render it wise for us to have a good navy render it wise for us to have a large navy.

The reasons why we need a good navy are that our coast exposes a great many billions of dollars worth of property to anybody who choses to destroy it; and that the great speed of modern ships, the great thickness of their armor, and the great range of their guns, together with the existence of cables under all the seas, enable any European country (and some South American countries) to concentrate a large fleet on our coasts and bombard our towns in three weeks after declaration of war. How could a small but good navy serve as a nucleus at such a time? Under the very best circumstances, could this nucleus be developed into a sufficient navy in three weeks?

It would require two years at least. And after the new navy had been built, comprising large ironclads with suitable engines, guns, etc., whom would we get to manage them? Where would we get men capable of properly handling and fighting these monstrous machines full of elaborate engines, of guns of a great many types, controlled by complicated apparatus, of torpedoes, of gun-cotton, and other high explosives, etc.? We could not find them in the navy, because, granting that all the men in the navy had not long since been killed, we only had enough men originally in the navy for the nucleus; and the drafting of several thousand men at hazard, and the putting of them on board modern ships to manage their electrical apparatus and gun-cotton, might perhaps be a very interesting experiment, but it can hardly be prophesied in advance that it would be a successful one.

It must be plain that the expression "a small but efficient navy" is meaningless, because a navy cannot for our purpose be efficient if it is small. A navy to be efficient must fulfill the purpose for which it was intended, and as the principal purpose for which our navy is intended is to protect our coast against a sudden attack by a large modern fleet, it cannot be efficient unless it can repel that attack; and to do this it must comprise a great number of armored ships, equipped with the best and latest apparatus and manned with officers and men capable of handling that apparatus.

WATER

SHREVEPORT, LA.—The contract for the water-works and sewerage of Shreveport, La., advertised recently in ENGINEERING NEWS has been awarded to Samuel R. Bullock & Co., of New York City. Work will be commenced at once.

WELL SAID.—The New Bedford *Mercury*, reporting the proceedings of the Water-Works Association in that city, says: "After some further discussion, driven wells were taken up." That must be an association of experts.—Lowell *Courier*.

LITTLE ROCK, ARK.—Col. Zeb. Ward is building new water-works, the rapid growth of the city requiring works of greater capacity than those now in use. The pumps will be of the compound duplex type, built by the Geo. F. Blake Co. The reservoir is situated two miles from the city, and has a holding capacity of 20,000,000 gallons. This is said to be the only instance where a city the size of Little Rock is supplied with water-works built, owned and managed by a single individual.

THE Connecticut river, and the streams that make it, furnish power to 2,298 mills. These take 118,026 horse-power. The greatest number on any one stream are on Miller's River and its tributaries, 188, with 7,572 horse-power; the second is Chicopee river and its tributaries, 182 mills, with 14,991 horse-power; and the Farmington is third with 178 mills and 8,852 horse-power. The greatest power, however, is taken from the Connecticut itself, whose main stream supplies 98 mills with 23,366 horse-power.

CONSTANTINOPLE, TURKEY.—The Imperial Ottoman Ice Co. (Limited) has been formed for supplying Constantinople with ice. Capital $500,000. Franchise, a monopoly of twenty-five years to build factories and manufacture ice. Ice heretofore has come from Norway and was almost prohibitive in price. The population of Constantinople is estimated at 1,300,000 with about 3,000 cafés, 2,000 water sellers and nearly 1,000 ice cream makers, so that a good demand for ice is anticipated. The promoters get $450,000, leaving $50,000 as working capital. It is an English company, and Mr J. Spencer Balfour, M. P., one of the directors, estimates the profits at over $100,000 per annum.

CLINTON, MO.—The water-works are being built by P. B. Perkins. The capacity is to be 1,500,000 gallons per day. The supply of water will be drawn from Grand

No. 21. Water Pressure in Mains of Various Cities.

COMPILED BY J. J. R. CROES. FROM SPECIAL RETURNS, MAY, 1886.

Town and State.	Topography.	Difference of level in town.	In Business District.		
			Day Pressure.	Night Pressure.	Fire Pressure.
		feet.	lbs.	lbs.	lbs.
Mt. Joy, Pa.	undulating.	——	20 to 40	20 to 40	45 to 50
Mt. Pleasant, Mich.	level.	0	25	25	60 to 100
Mt. Vernon, Ohio.	hilly.	65	85 to 110	85 to 110	100 to 150
Muscatine, Ia.	hilly.	69	75 to 90	75 to 90	90 to 150
Pullman, Ill.	level.	6	13	13	75
Seattle, W. Ter.	hilly.	380	80	80	80
Sidney, Ohio.	hilly.	20	50	50	100 to 200
Smethport, Pa.	hilly.	50	50 to 60	65	50 to 65
Somerville, Mass.	undulating.	——	55	60	55
South Bethlehem, Pa.	hilly.	100	80 to 90	80 to 90	80 to 90
South Evanston, Ill.	level.	10	18	24	18 to 24
Southington, Conn.	undulating.	30	98	98	98
So'th Norwalk, Conn.	rolling.	100	60	75	60 to 75
Sorel, Que.	level.	0	60	60	120
Spencer, Mass.	hilly.	——	70	70 to 80	70 to 80
Springfield, Mass.	hilly.	135	35 to 100	35 to 100	100 to 125
Waverly, N. Y.	level.	0	87	87	87
Webster, Mass.	hilly.	——	40	40	150 to 180
Webster City, Ia.	level.	0	30	30	30 +
Wellsville, N. Y.	hilly.	80	85	85	85
Wellsville, Ohio.	level.	20	115	115	115
Westfield, Mass.	level.	0	115	123 to 125	——
West Haven, Conn.	level.	0	38	45	38 to 45
We-tminster, Md.	hilly.	50	80	80	80 to 200
Whitehall, N. Y.	hilly.	100	110	110	——

river bottom, where a shaft 40 feet deep was sunk, and drifting toward the river was done for a distance of 150 feet. The resulting water is pure and soft. In the equipment of the plant Mr. Perkins will use his own pumping machinery. The water tower will be 11 feet in diameter and 115 feet high. There will be about six-and-a-half miles of cast-iron pipe, and some fifty-five hydrants. Work was begun April 20, and the contract will be completed in August.

NEWS OF THE WEEK.

Contracting.

Dumping Scow.—Sealed proposals, addressed to the City Engineer and endorsed "Proposals for Dumping Scow," will be received at the office of the City Engineer, Boston, Mass., until 12 m. of Tuesday, the 20th day of July. Plans and specifications may be seen at the office of Improved Sewerage, 74 Tremont street, Boston.

Foundry.—Proposals are invited for furnishing and delivering at Oriskany, N. Y., dimension stone, lime, sand, brick, timber and roofing materials for the Oriskany Malleable Iron Co.'s new works. For further information apply to W. H. Symonds, architect, 36 Mann Building, Utica, N. Y.

Road Machine.—A trial has been made at New Orleans, La., with the Lamborn road machine. It consists of an iron frame work and carries an adjustable stee blade scraper set at an angle. This blade on being lowered scrapes along the surface, cleaning it up as it goes and when it is required to fill a hole or depression the blade is raised and the material dropped at the proper place. It is adapted to dirt streets and shell roads and throws its cut from the ditch bank to the centre of the road, thus gradually raising the level of the middle of the street and affording better drainage.

Curbing, Sewers, Pipe, Etc.—At Des Moines, Ia., the following bids have been received. *Curbing*; Tuttle & Cory, cement curbing, 48½ cents per foot; Thos. O'Connor, Berea standstone, 5 by 24, 74 cents; 5 by 20, 59 cents; Portland cement, 49¼ cents; Thos. Millett, cement, 43½ cents; S. Green & Son, $1, or 80 cents for same curbing as used last year; J. B. M'Gorrisk, Berea sandstone, 62 cents. *Pipe*; Burnside & Keho, ¾-inch lead pipe for water connections, 28 cents per foot; 6-inch sewer pipe for sewer connections, 47 cents per foot. *Sewers*; Sewer No. 10, E. Skelsey, $1.40; No. 12, E. Skelsey, $1.35; Nos. 13 and 14, Holmes & Co., $1.24; No. 15, E. Skelsey, $1.34. *Paving*; cedar block, lowest bid, J. B. Smith & Co., $1.41 per yard. Contracts for sewers have been awarded as follows: Sewer No. 2, P. H. McCauly, $1.07 per lineal foot; No. 3, P. H. McCauly, $1.74; No. 4, Kennedy & O'Brien; No. 5, S. B. Tuttle, $1.75; No. 7, Kennedy & O'Brien, $1.39. A resolution was adopted to purchase a cement testing machine for the engineer to use in testing the cement that the contractors propose to use for the curbing.

Sewers.—Sealed proposals will be received at the office of the City Clerk, Lincoln, Neb., up to 12 o'clock (noon) of Wednesday, July 29, for the construction of sewers in accordance with plans and specifications on file in the office of the City Clerk. The following is the estimated cost of the work:

10,000 lin. feet 6-inch pipe, 12 feet deep, at 50c	$5,000
60,000 lin. feet 8-inch pipe, 12 feet deep, at 55c	33,000
2,600 lin. feet 10-inch pipe, 12 feet deep, at 60c	1,560
4,430 lin. feet 12-inch pipe, 12 feet deep, at 65c	2,880
3,210 lin. feet 15-inch pipe, 12 feet deep, at 80c	2,568
1,230 lin. feet 18-inch pipe, 12 feet deep, at $1	1,230
2,740 lin. feet 20-inch pipe, 12 feet deep, at $1.25	3,425
	$49,663
70 flush tanks at $100	7,000
67 manholes at $60	4,020
10,000-gallon flush tank	1,000
	$61,683
10 per cent, superintendence and contingencies.	6,168
	$67,851
10 per cent, engineering	6,785
	$74,636

Masonry and Bridge.—F. A. Dunham, C. E., Plainfield N. J., has the letting of masonry for an iron bridge up to the 22nd. inst.. The building of a new iron bridge was up for discussion in the North Plainfield Council ot its last meeting.

Railroads, Bridges and Canals.

The Tower Bridge.—The foundation stone of the new Tower bridge, over the Thames, at London, England, was laid by the Prince of Wales, June 21st. A distinguished company was present, including Mr. John Wolfe Barry, M. I. C. E., Sir John Fowler, M. I. C. E., and the city architect, Mr. Horace Jones, M. R. I. B. A. The bridge is 880 feet long, in three spans, the center one—200 feet—having tall massive towers on its piers and being a bascule bridge, the two halves swinging to a vertical position against the towers. To provide for foot traffic while the draw is open, a fixed bridge is thrown across the center span at a height of 130 feet above high water, access being obtained to this bridge by means of stairways and hydraulic elevators in the towers; the machinery for raising the draw will also be hydraulic, and will be entirely concealed within the towers. Vehicular traffic must wait until the draw is closed, but this interruption to traffic is not expected to last more than four or five minutes, once or twice a day. The approaches and land spans are 60 feet wide, and the center span 50 feet wide; the steepest grade of the approaches is on the southern side, where it amounts to one in forty. The cost of the entire structure, including machinery and approaches, is estimated at $3,750,000, and the time for its completion is set at between three and four years.

Fast Tunnel Driving in the New York Aqueduct.—Section A. of the New Croton Aqueduct, comprising shafts Nos. 22, 23 and 24, is being driven by Rodgers & Farrell. Both gentlemen were pioneers in the application of machinery to rock exeavation, and their experience extends over a great part of the heavy tunneling of late years. Mr. Edward Farrell of the firm is in immediate personal supervision of this work. Remarkable progress has been made in the work on this section, which extends for the whole distance through granitic gneiss.

At eight o'clock of Tuesday, June 22d, the headings between shafts Nos. 22 and 23 met. In the north heading of shaft No. 23, 254 feet 6 inches of full section tunnel was driven in twenty-two days. In the south heading of the same shaft, 265 feet 6 inches of full section tunnel was driven in twenty-six days. In the north heading in one week, foremen J. Kelly & Morgan Flynn drove 83 feet of full section tunnel. In the south heading, foremen Fred Hamilton and Morgan Callahan, in one week drove 75 feet of full section tunnel. Foremen Hamilton and Callahan with their 266 feet 6 inches of complete tunnel, have made the best monthly progress on the fifteen miles of tunnel under contractors O'Brien & Clark, and foremen Kelly & Flynn with their 83 feet of complete tunnel in one week lead the boys on the entire line of work. To the gang making the greatest monthly progress, Contractors O'Brien & Clark offered a cash prize of $300 and to that making the second best, $200, which prizes have been well and fairly won by Hamilton & Callahan with their boys in the south heading, by a record of 265 feet 6 inches and by Kelly & Flynn whose gang in the north heading show 254 feet 6 inches. The greatest advance by one blast, was made with Forcite Powder, Nos. 1 and 2, in which by the blasting of a single round of holes, 9 feet 4 inches of full section tunnel was gained.

Five 3½-inch "Eclipse" Ingersoll drills are used in drilling in each face. These machines are employed exclusively on this section, having replaced the Band drills early in the progress of the work.

CORRESPONDENCE.

Magnetic Bearings.

CHAMPAIGN, ILL., July 10, 1886.

EDITOR ENGINEERING NEWS:

Having just seen the Transactions of the American Society of Civil Engineers, for May 1886, and read the article "On Increasing the Accuracy of a System of Magnetic Bearings of a Survey," I write to suggest that the above method simply averages the errors of observation and local attraction, and that only by the use of a transit; the method proposed in ENGINEERING NEWS Oct. 31, 1885, (Vol. XIV), page 277, eliminates local attractions entirely, and affords a simple and direct means of distributing the error equally among the sides or unequally according to the judgment of the surveyor. The latter method requires only a common magnetic compass.

I. O. B.

Algebraic.

DEFIANCE, O., July 6, 1886.

EDITOR ENGINEERING NEWS:

Is it a fact generally known among those who write up our algebras that the equation $x^3 - qx \pm r = o$ can be solved accurately and exactly even though it contain three real and unequal roots? The solution is obtained by the use of circular functions. Thus if we put $\cos. \varphi = \sqrt{\frac{27 r^2}{4 q^3}}$ then the three roots are

$$-2\left(\sqrt{\frac{q}{3}}\right) \cos. \left(\frac{\varphi}{3}\right);$$

$$-2\left(\sqrt{\frac{q}{3}}\right) \cos. \left(\frac{\pi \pm \varphi}{3}\right)$$

See Hymers Theory of Algebraic Equations art, 92, p. 102, edition of 1858. It thus only becomes a matter of five minute's work to find the roots even to the sixth decimal place. The solution for equations containing imaginary roots is also obtained by the use of these functions, but the rule is necessarily different. Readers are referred to the book.

Yours respectfully,
C. H. LINDENBERGER.

The Accident to the Great Eastern.

NEW YORK, July 12, 1886.

EDITOR ENGINEERING NEWS:

Noticing your article in the ENGINEERING NEWS of July 10th, referring to the late Hamilton E. Towle, I can vouch for the truth that he saved the "Great Eastern" in September, 1861, having been one of the "six hundred" who expected the ship to go down.

Through Mr. Towle's efforts with the help of the detail of seamen that remained sober to assist in placing the ship's cable with the chain purchases to work the rudder, by which means the ship was navigated to Queenstown.

Mr. Towle was allowed to try his plan of wrapping the cable on the rudder stock stump after the several experiments the captain of the ship had made which all failed, together with his offering to purchase the Canadian loaded brig and cargo (communicated by signals) which the captain of the brig refused, but who promised to lay near the steamer as long as she floated or until she arrived in port.

Yours truly,
ALEX. J. HOWELL.

A Great Irrigation Tunnel.

Cheyenne Sun.

The Sabille ditch irrigation tunnel, twelve miles southwest of Squaw mountain and seven miles above Laramie canon, in Wyoming Territory was recently completed.

"The object of the tunnel was to convey water from the Laramie river into Blue Glass creek, which empties into the Sabille about thirteen miles above Swan's 2—ranch. In order to secure the water and accomplish this object it was necessary to bore a tunnel directly through a rocky divide, which separated Laramie river from Blue Grass creek, the lowest sag of which was 100 feet above the point of entrance and the highest 302 feet. The extent of the boring was 2,985 feet or a little less than three-quarters of a mile. The scheme was first undertaken two years ago last October. At the commencement of the work a small engine and a light air compressor were brought into requisition and 400 feet of excavation was finally accomplished, beginning at the north face of the mountain. The character of the rock gone through was hard granite and micacious schist and the work of boring was attended with such extraordinary difficulties that it was finally abandoned as impracticable.

At this period of the undertaking the work of tunneling would have been given up altogether if it had been found possible to divert part of the Laramie river farther up the stream into Blue Grass creek, but this could not be done.

Last October the company secured the services of Mr. Frank Bartlett, civil engineer, of Cheyenne, and to him they gave a "carte blanche" to proceed as his best judgment dictated. After a thorough survey of the situation Mr. Bartlett became convinced that owing to the adamantine character of the rock it would be impossible to prosecute the work with the light machinery on hand. It was decided to build a mill race from the Laramie river a short distance above the mouth of the tunnel and the company then procured a 14,000-pound turbine water wheel, the largest ever brought west of the Mississippi river. At the same time they introduced a new duplex air compressor of extraordinary power. From this, air pipes were extended 3,500 feet across the mountain to the south opening of the tunnel and the work of drilling and excavating was then begun in dead earnest at both ends. From that time on the work progressed very rapidly, until Thursday morning at 4 o'clock when the shell of rock between the north and south end was broken through. The ends met perfectly showing the accurate calculations that had been made by the engineer.

The tunnel is 7 feet high by 8 feet wide and is of sufficient capacity to carry 1,500 cubic feet of water per second. A 16-feet fall is given the water from the mill race in the river to the mouth of the tunnel on the north side. The fall from the north side to the south is 35 feet, the object of course being to cause such a rush of water as to sweep before it any artificial impediment that might rise.

After the water is taken from the Laramie river through the tunnel it emerges into Blue Grass creek, through which it runs for fifteen miles before emptying into Sabille. It is then discharged through two main and several lateral ditches for irrigating purposes. The first main ditch is taken out a mile and a half from where the Blue Grass empties into the Sabille. This ditch is thirty-seven miles long and 25 feet wide in the bottom. The second main ditch is taken out opposite the Mule Shoe ranch and is nineteen miles long and 20 feet wide at the bottom. There are about nineteen miles of lateral ditches varying from 12 to 6 feet in width. The system is now entirely complete and ready for the water which was turned in last evening.

The object of this extraordinary undertaking was to reclaim a plateau of land, embracing 60,000 acres, which lies between the Sabille and Chug. The entire expense undergone by the company, it is said, will closely hug half a million dollars.

Mr. J. A Johnson had the general superintendence of the work, while Mr. Charles Jones had immediate charge of the excavations in the south end and Mr. Oscar Riggs in the north end.

The Erie Express.

Railway News (London).

The movement to get rid of the agency of "express" companies continues to spread to the great benefit of railroad proprietors. The Erie Company now takes the field in this campaign, although the manner in which the reform has been brought about does not redound to the credit of its managers; but whatever may be the reasons for the change, the advantage is the same in ending arrangements by which the most profitable part of a railroad is handed over to an outside corporation. The withdrawal of the United States Express Company from the Erie road left it without any express company at all, and, as a matter of necessity, one has to be arranged. The story of the change of the United States Express from the Erie to the Delaware, Lackawanna and Western Railroad makes an interesting history.

The United States Express Company for years sent its express matter over the Erie road. Several carloads of packages were hauled with every express train on the Erie. The contract expired recently, and just before its termination the presidents of both corporations had a consultation about a new one. By the old one the express company guaranteed to the Erie a minimum sum to be paid it for transporting the cars. This minimum sum was $1,000 per day. President King wanted this minimum guarantee raised to $1,800 per day; but after considerable correspondence, the negotiations were broken off, and the United States Express Company transferred its business to the Erie's rival, the Delaware, Lackawanna and Western Company, although another corporation already occupied the ground. This Lackawanna Express Company, it appears, was not owned by the railroad company at all, but was a side arrangement, the stock being held entirely, if not altogether, by the officers and large stockholders of the Lackawanna. A traffic contract had existed between the express and the railroad company, but it expired years ago, and had not been renewed, although settlements were made according it its provisions.

The Lackawanna Express paid the Delaware, Lackawanna and Western Railroad Company only $150 000 per year; while the United States Company was ready to guarantee $365,000 per year, and on a traffic contract such as proposed, the railroad company will receive probably $450 000 per year. The United States Company was further willing to buy up the plant of the Lackawanna Express. The arrangement was made, and President Sloan and President Platt signed the contract. The arrangement, it is said, was made at the instance of Jay Gould, who is the principal proprietor of the Pacific Express, which operates over the Wabash, Missouri Pacific, and other Gould lines, and which was in need of an eastern connection. He came in for his reward in the shape of an advantageous contract with the United States Company for the interchange of business at Toledo and Chicago. The Lackawanna's lines run to Buffalo, and from that point to Chicago the United States will use the Lake Shore road, with which it has a traffic contract. The Pacific Express Company has thus secured a powerful eastern connection that cannot fail to be profitable to it, and the United States has also gained a wider field for its operations. Both sides are well pleased with the contract.

There was thus only one thing for the Erie to do, and that was to organize an express company of its own. The directors of the company promptly voted to expend $300,000, or as much of it as should be necessary, in organizing the service. Horses and wagons have had to be bought, offices established in New York and other large cities, and arrangements made with transportation lines and other express companies. It was a tremendous task, and it will be the middle of June before the new organization is perfected. The small amount of the expenditure involved, however, forms the strongest condemnation of the whole express system. The Lackawanna gains $300,000 a year, and the United States reaches much better territory than it did under the old arrangement. It can still run to Binghamton and Buffalo, and besides gets access to Syracuse, Corning, and the large interior towns of New York State. Meanwhile, the Erie must build up its business as best it may under the disadvantage of a sudden and unexpected change of policy. Meantime, it is reported that the Erie road is obliged to run its new express over the Baltimore and Ohio from Mansfield to Chicago, the United States Express having got ahead on the Chicago and Atlantic through a contract made for several years and approved by both Mr. Jewett and Mr. Bonedict.

TRADE NOTES.

(Twenty cents per line per insertion.)

CENTRIFUGAL PUMPS.

LOWELL, MASS., July 8, 1886.

LAWRENCE MACHINE SHOP, LAWRENCE, MASS.:

The three Centrifugal Pumps, class "B," 6-inch, 5-inch and 4-inch respectively, with fittings, which you furnished the Union Water Power Company last season, for the repairs of their upper dam, at the outlet of Lake Mooseluckmaguntic, Oxford county, Me., were used throughout the work, and proved to be satisfactory in every respect, and their performance came fully up to your representations.

Very truly yours,

[Signed] JAMES B. FRANCIS,
Consulting Engineer.

Market Report of Engineering Materials.

New York July 15, 1886.

IRON.

STRUCTURAL IRON.		
Angles	2.00c	@ 2.10c
" steel	2.35	@ 2.45
Tees	2.40	@ 2.45
Beams and channels, American	3.0	@
Tank plates	2.10	@ 2.20
Shell plates	2.4	@ 2.5
Steel plates, Tank	2.70	@ 2.75
WROUGHT-IRON PIPE, PITTSBURG.		
Butt welded, black, Discount		45
" " galvanized "		35
Lap welded, black "		60
" galvanized "		42½
Boiler tubes "		52½
RAILS.		
Steel (large lots at mill)	$31.00 @	$35.00
Old rails	18.50 @	19.00
Old rails, steel	22.00 @	23.00
R R. spikes		2.40c
R R, splice-plates	1.80 @	2.00
R R, track bolts, square nuts	3.00	
Barb-wire fencing, galvanized	4.38	
" painted		4.00
Corrugated iron		
Nails		
Iron, per keg	2.00 @	2.05
Steel do.	2.55 @	2.60

METALS.

COPPER.		
Lake Superior	9.75 @	9.86
Other Brands	9.00 @	9.50
LEAD.		
Com. Domestic		4.90
Lead Pipe	.06¼c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	$5.60 @	5.75

BRICK.

Cargoes (afloat)		
Choice Brands	7.50	
Haverstraw per M.	6.75 @	7.25
Fishkill	7.00	
Up-River	6.00 @	6.50
Jerseys	5.50 @	6.75
Long Island	6.50 @	6.75
Pale	4.50 @	4.75
FRONTS.		
Croton, red	11.00 @	15.00
" dark	11.00 @	15.00
" brown	10.00 @	14.00
Philadelphia pressed	24.00 @	28.00
Trenton "	24.00 @	26.00
Baltimore "	37.00 @	41.00
Buff "	33.00 @	35.00
Enameled English	85.00 @	130.00
" American	90.00 @	120.00
Fire brick	25.00 @	55.00
" American, No. 1	30.00 @	35.00
" " No. 2	25.00 @	30.00

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

CALVIN TOMKINS:		
"Old Newark Co's." Cement		$1.10
BAETJER & MEYERSTEIN:		
Hanover Portland	$2.60 @	$2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
Burham	2.25 @	2.50
Fewen	2.25 @	2.50
BROOKS, SHOOBRIDGE & Co.	2.45 @	2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.50 @	2.75
K. B. & S. " "	2.25 @	2.50
Stettiner, German	2.65 @	2.85
Lagerdorfer, "	2.45 @	2.75
Fieve, A 1, Belgian	2.35 @	2.50
Roman	2.75 @	3.00
Keene's Coarse	4.75 @	5.50
" Fine	7.75 @	8.50
" Superfine	8.50 @	10.00
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	2.40 @	2.75
GABRIEL & SCHALL:		
Vorwohler "Lion"	2.65 @	3.10
HUDSON RIVER CEMENT Co. Rosendale		0
JOHNSON & WILSON:		
Saylor's American Portland	2.15 @	2.45
LESLEY & TEINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20 @	2.40
Improved "Union"	1.25 @	1.50
Union	1.10 @	1.20
MARCIAL & Co.:		
J. B. White & Bros. Coarse Keene's	4.25 @	4.50
" Superfine	7.25 @	7.50
" Portland	2.65 @	3.00
NEW YORK CEMENT Co.:		
Rosendale		1.10
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAWSON:		
Alsen's Portland Cement Works	2.35 @	2.85
K. B. & S.	2.25 @	2.50
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90 @	3.25
UNITED STATES CEMENT Co.:		
English Portland	2.25 @	2.40
German "	2.00 @	2.15
Standard	1.50 @	1.65
Windsor and Improved Rosendale	1.00 @	1.10
UNION AKRON CEMENT Co.:		
Akron "Star" brand	1.00 @	1.10

ASPHALT.

ROCK.		
Prices range per ton	$15.00 @	20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50 @	$3.

LIME.

Rocklock Cement Co.'s Ground	.80
Rockland, common per bbl	1.00
" finishing	1.20
State, common	.85
" finishing	1.10
Kingston, ground	.90
Add 25c. to above figures for yard rates.	

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95 @	1.00
" " No. 2 "	0.75 @	0.85
" " light drab "	0.80 @	0.95
Berlin " in rough "	0.75 @	1.00
Berea " "		
Brown stone, Portland, Ct. "	1.00 @	1.35
" Belleville, N. J. "	0.75 @	1.35
Granite, rough	0.45 @	1.25
Common building stone per load	2.00 @	3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40 @	3.00
Concrete and macadam stone, Tomkins Cove, per cub. yd		$1.65

SLATE.

Purple roofing per square	6.00 @	7.00
Green "	6.00 @	7.00
Red "	15.00	
Black Penna. (at New York) "	4.50 @	5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00 @	20.00
Choice "	65.00 @	70.00
Tally plank, 1¼ in. 10 in. dres'd, each	.44 @	.50
Tally boards, dressed com. "	.28 @	.30
SPRUCE, Boards dressed "	.25 @	.28
Plank, 1¼ in "	.28 @	.30
" 2 in. "	.38 @	.40
" 2 in. dressed "	.43 @	.45
Timber per M.	13.00 @	16.00
HEMLOCK, Boards each.	.18 @	.20
Joist, 2½ × 4 to 4 × 6 in	.16 @	.44
OAK per M.	55.00 @	65.00
CYPRESS 1, 1½, 2 and 2½ in "	35.00 @	40.00
YELLOW PINE, Girders "	25.00 @	30.00
Dressed flooring "	28.00 @	35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75 @	6.00
LATH, Cargo rate "	2.00 @	2.10

PAINT.

Lead, white, American dry per lb	.04¾ @	.06½
" " " in oil pure "	.07 @	.07½
" English, B. B. in oil "	.08¾ @	.08¾
" Red, American "		.06¾
Litharge "	.05½ @	.06
Venetian red, American "	.01 @	.01¼
Indian red "	.08 @	.10
Vermillion, American lead "	.10½ @	.11¾
Paris green "	.15 @	.18
Umber, Amer. raw and powdered per lb.	.01¼ @	.01¾
Drop black, Amer.	.07 @	.13
" " Eng.	.11 @	.13
Chrome green	.10 @	.25
Oxide zinc, American	.03½ @	.03¾
" French	.05½ @	.07¾